VOLUME XXIX MARCH, 1941 NUMBER 10

THE PHILIPPINE AGRICULTURIST

UNIVERSITY OF THE PHILIPPINES PUBLICATIONS: SERIES A

CONTENTS

The Livestock Industry of Australia -- By *F. M. Fronda* 813
Studies on the Food of 112 Families of Laborers of the Philippine Lumber Manufacturing Co., Catabañgan, Ragay, Camarines Sur -- By *F. O. Santos and N. A. Pidlaoan* 826
Effects of Certain Cryptotrophic Elements upon the Growth and Yield of Upland Rice ---------- By *Esteban Y. Castillo* 833
The Effect of Pruning at Varying Ages upon the Yield of Ramai Rice ---------- By *Ramon D. Rojas* 851
A Study on Budding the Star Apple with Special Reference to the Modified Forkert Method -- By *L. G. Gonzalez and Pedro E. Gloria* 861
Determination of Fertilizer Requirements of Corn Plant when Grown in Lipa Clay Loam -------- By *José Madrigal, Jr.* 877
Bamboo Catheters in the Treatment of Udder Troubles ------ By *Miguel Manresa and F. B. Sarao* 892
The Effects of Different Kinds of Planting Materials and of a Commercial Fertilizer on the Production of Flowers of Tuberose -- By *Vicente M. Dawis and José O. Jaug* 896
Published Contributions of the College of Agriculture: XVIII -------- By *L. B. Uichanco* 909
College and Alumni Notes ---------- 917

Published by
THE COLLEGE OF AGRICULTURE
UNIVERSITY OF THE PHILIPPINES

COMMONWEALTH MYCOLOGICAL INSTITUTE
10 OCT 1961
IMPERIAL BUREAU OF PASTURES & FORAGE CROPS
LIBRARY
ABERYSTWYTH, GREAT BRITAIN.
18 FEB 1942

The Philippine Agriculturist

(University of the Philippines Publications: Series A)

Editor

L. B. UICHANCO, SC.D. ..... *Dean, College of Agriculture*

Managing Editor

G. O. OCFEMIA, PH.D. ..... *Associate Professor of Plant Pathology*

Copy Editor

RUTH MCCULLOUGH MACK, M.A. ..... *Assistant Professor of English*

Advisory Board

N. B. MENDIOLA, PH.D. ..... *Director of Research*
R. B. ESPINO, PH.D. ..... *Head, Department of Agricultural Botany*
F. O. SANTOS, PH.D. ..... *Head, Department of Agricultural Chemistry*
A. L. TEODORO, PH.D. ..... *Head, Department of Agricultural Engineering*
VALENTE VILLEGAS, PH.D. ..... *Head, Department of Animal Husbandry*
DIONISIO I. AQUINO, PH.D. ..... *Acting Head, Department of Soils*
FRANCISCO M. SACAY, PH.D. ..... *Acting Head, Department of Agricultural Education*
JOSÉ E. VELMONTE, B.S.C. ..... *Acting Head, Department of Agricultural Economics*
LEON G. GONZALEZ, PH.D. ..... *Acting Head, Department of Agronomy*

Business Manager

JOSÉ M. CAPINPIN, PH.D. ..... *Assistant Professor of Agricultural Botany*

Authors of articles appearing in THE PHILIPPINE AGRICULTURIST are severally responsible for the opinions expressed therein.

THE PHILIPPINE AGRICULTURIST is published monthly, except in April and May, by the College of Agriculture, University of the Philippines, Los Baños, Laguna. The subscription price is ₱4.00 a year in the Philippines and $2.50 elsewhere; the price of single copies, 40 centavos in the Philippines and 25 cents elsewhere.

Business correspondence should be addressed to the Business Manager, THE PHILIPPINE AGRICULTURIST, Agricultural College, Laguna, Philippines. All remittances should be made payable to THE PHILIPPINE AGRICULTURIST.

Communications for the editor should be addressed to the Editor, THE PHILIPPINE AGRICULTURIST, Agricultural College, Laguna, Philippines.

Publications sent in exchange for THE PHILIPPINE AGRICULTURIST should be addressed: Library, College of Agriculture, Agricultural College, Laguna, Philippines.

Entered at the Post Office at Agricultural College, Laguna, Philippines, as second-class mail matter.

THE LIVESTOCK INDUSTRY OF AUSTRALLA [1]

F. M. FRONDA
Of the Department of Animal Husbandry

WITH FIVE TEXT FIGURES

Australia is eminently a pastoral country. All of the states in the Commonwealth are livestock states, wool and stock being their staple products. Although when the first livestock census of the country was taken in 1788, there were only seven horses, seven cattle, twenty-nine sheep, seventy-four pigs, and nineteen goats (Wilson, 1939),[2] at present most of Australia's exports are derived from her pastoral industry. The pastoral industry of Australia, however, has not been without disappointments, but those engaged in the industry did not allow themselves to be discouraged. There were years when, because of prolonged droughts, the industry suffered from severe losses. In spite of these recurrent discouragements, the industry has grown to such an extent that a considerable part of the wealth of the country at present is derived from her livestock industry. During the last ten years, 1928-1929 to 1937-1938, pastoral, dairy, and farmyard products represented 58.7 per cent of the total exports of Australia.

That Australia's livestock industry should occupy a premier position in the industries of the Commonwealth should not be wondered at. In addition to its wonderfully favorable climatic conditions, the Government is very interested in the essential needs of the industry. On the recommendation of the Australian Agricultural Council, a scheme of assistance was introduced in 1935 to help stock breeders. To encourage the breeders to import pedigreed cattle, sheep, milch goats, and certain breeds of swine from the United Kingdom, stock owners have been granted subsidies of £50 (₱325.00) per head of cattle, £25 (₱162.50) per head of pigs of specific breeds, and £20 (₱130.00) per head of sheep and goats imported. The Commonwealth Government, the Commonwealth Bank of Australia, and

---

[1] General contribution No. 772.

[2] The statistical figures given in this report, unless otherwise stated, are from the *Official Yearbook of the Commonwealth of Australia* prepared by Roland Wilson, Government Statistician.

the state governments contribute equal proportions to this fund. Individuals other than stock owners may make importations under this scheme, but the subsidies are paid to the stock owner who subsequently purchases the stock from the importer.

Horses. All classes of horses, heavy, draft, medium, light saddle, and carriage horses, are bred in Australia. Australian horses are highly valued for military purposes. This is particularly true in India, to which country over eighty per cent of the average horse export of Australia has been consigned for remount purposes.

High class stud-horses were imported from the United Kingdom and from New Zealand for improvement purposes. These were mated with carefully selected Australian mares, and the results obtained compare favorably with those bred in other lands. Although at present horse breeding is not so popular as it was in the past on account of the development of motor transportation, interest is again being awakened. Riding clubs are popular among the younger people. Such clubs are now found in many places and their membership is gradually increasing.

In 1937, there were 1,746,500 horses in the Commonwealth, or about 0.25 per capita of human population. Of these, more than seventy-six per cent were depastured in New South Wales, Queensland, and Victoria.

Beef cattle. Australia in 1937 ranked as the ninth cattle producing country of the world. Then, there were 13,078,300 head in the country, or 1.90 per capita. Cattle rasing is carried on in all states of the Commonwealth with Queensland leading all the other states in the number raised. For many years, cattle (fig. 1) was raised only to supply the local demand for beef, but with the establishment of the frozen meat export trade, the number of cattle depastured increased considerably. During recent years, a considerable amount of chilled beef has been added to the list of exports of Australia. This is exported mainly to the United Kingdom, 92.2 per cent having been exported to that country in 1937. Egypt, British Malaya, Japan, and the Philippines have been fairly regular importers of Australian beef.

Shorthorn and Hereford cattle predominate in Australia. Polled Angus has also been introduced successfully. Devon cattle may be found in many places. Some Zebus were introduced from Taxes not many years ago and crossed with the established breeds of cattle of the country to produce tick fever resistant animals. According

to the progress reports so far issued, highly promising results have already been obtained (Julius, Rivett, and Richardson, 1939). In spite of the apparent success of the venture, however, there are a number of cattle growers who disapprove of this cross as they claim that the animals become very wild and unmanageable under existing ranch conditions and this makes it difficult to round them up.

Dairy cattle. Of the 13,078,300 head of cattle that the country had in 1937, 3,368,900, or about 25.8 per cent, were dairy animals. In Victoria, Jerseys (fig. 2), Ayrshires, Red Polls, and Holstein-Friesians have been found the most satisfactory (Gawler, 1939). In New

Fig. 1.—A sample of market cattle. Brisbane, Queensland.

South Wales, the Shorthorns predominate. The Illawara, resulting from crosses with different breeds, is also a useful dairy breed in this state. There are also herds of Jerseys in New South Wales, the use of these animals for butter production being on the increase. Ayrshires have been noted for their hardiness, and they are especially favored for the production of milk for consumption as fresh milk rather than for buttermaking (Carver, 1939).

Victoria is the most important dairy state of the Commonwealth. In New South Wales, dairy cattle are raised mostly in the eastern coastal regions, while in Queensland, dairying is concentrated in the southern half of the state. Queensland prides herself on being the only country that has profitable commercial dairy farms conducted wholly in the tropics. Although the quantity of milk produced an-

nually per dairy cow varies according to the breed, locality, and season, the average production of the over three million cows in Australia in 1937-1938 was 360 gallons (1,362.7 l.) of milk. The mean production for the year varied from 324 gallons (1,226.4 l.) in New South Wales to 446 gallons (1,688.2 l.) in South Australia (Wilson, 1939). In Victoria, the highest yield of butter recorded from an animal was 859 lbs. (390.4 kgms.) in one year (Gawler, 1939).

In addition to butter and cheese, there is a considerable output of condensed, concentrated, and powdered milk in Australia. Victoria leads in the production of these milk products, with New South Wales second. From information received, there is a law in Victo-

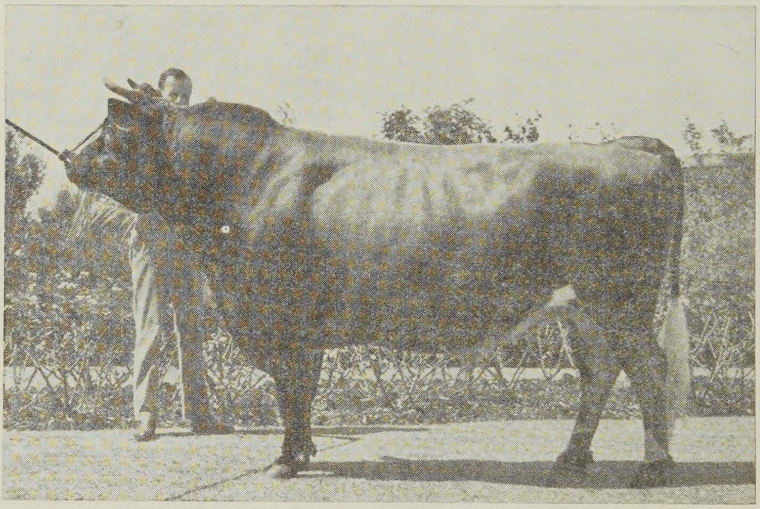

Fig. 2.—"Design's Ruler", a Jersey bull owned by Navua Stud Farm, Grose Wold (via Richmond), New South Wales. Courtesy of Navua Stud Farm.

ria that prohibits the sale of powdered milk as human food after it has been in the tin for a year. Such products must be disposed of as animal feed.

In order to encourage further production, efforts are being exerted to increase the local consumption of both butter and cheese. In 1937-1938, the annual per capita consumption of butter in the Commonwealth was 33.9 lbs. (15.4 kgms.) compared with only 24.8 lbs. (11.3 kgms.) in the United Kingdom, 32.7 lbs. (14.9 kgms.) in Canada, and 40.71 lbs. (18.5 kgms.) in New Zealand. The per capita consumption of cheese in Australia during the same year was 4.3 lbs. (1.95 kgms.). In the United Kingdom, it amounted to 8.6

lbs. (3.9 kgms.); in Canada, 3.5 lbs. (1.6 kgms.); and in New Zealand, 8.0 lbs. (3.5 kgms.). A considerable amount of milk is consumed, either plain or in the form of milk shakes with various flavors. There are numerous milk bars in the cities and in towns.

Sheep. Australia stands first among the wool producing countries of the world, for in 1937 there were over 113,372,000 sheep (fig. 3), or 16.59 per capita of population, within the country. The Soviet Union, during the same year, reported about 66,600,000 head; the United States, about 52,918,000; the Argentine Republic, 43,700,000; and the Union of South Africa, 43,100,000 head. New South Wales is the leading sheep-raising state in Australia. In 1937, 45.5 per

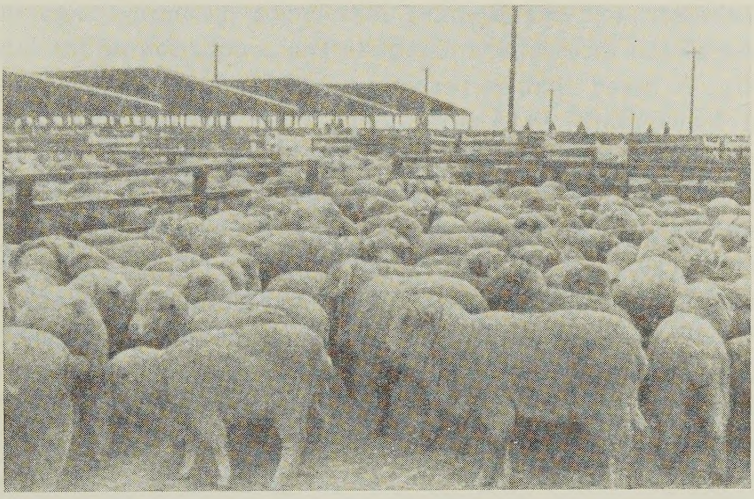

Fig. 3.—Sheep in the abattoirs. Brisbane, Queensland.

cent of the sheep of the Commonwealth were depastured in this state alone. Queensland follows next with 19.8 per cent, and Victoria comes third with 16.6 per cent. South Australia and Western Australia each had about eight per cent of Australia's sheep population that year.

The bulk of wool produced in Australia is exported, only about seven per cent of its wool being used locally by the Australian woolen mills. Although this country raises less than one-sixth of the world's sheep population, Australia provides more than one-quarter of the world's wool requirements. In addition to this, the exports of frozen mutton and lamb have increased considerably during the last

two decades. As with beef, the United Kingdom is the principal customer of Australia in the frozen mutton and lamb trade, absorbing about ninety-seven per cent of the total export of the country.

The principal breed of sheep raised in Australia is the Merino of which three types or classes are recognized, namely, the Fine, Medium, and Strong. The Fine Merinos are raised in sections of the country characterized by dry air with short, fine grass predominating; Medium Merinos abound where the country is richer, the feed of a stronger nature, and the climate temperate; and the Strong Merinos may be found in the open, unsheltered plains of the southern part of Australia and New South Wales. Crosses of the long-wooled breeds, like the Lincoln, which is the most common one used, the Leicester, and the Romney Marsh are becoming more popular because of the increasing interest in the production of fat lamb for export. A breed that is becoming popular is the Corriedale produced concurrently in Australia and New Zealand about 1875 by mating Lincoln rams with Leicester-Merino ewes. This breed is being favored by many breeders because it has proved to be good both for the production of fat lamb and wool. It is claimed that the Corriedale is very well suited to the hotter and drier areas of the Commonwealth. In Victoria about 1885, Merino ewes were mated with Lincoln rams and produced the Polwarth breed which is approximately three-quarters Merino and one-quarter Lincoln. This breed is considered to be an ideal farmer's sheep as it is claimed to produce a better carcass than the Merino and a splendid fleece of long-stapled wool. The Wanganella is also popular in all the states in the Commonwealth.

The bulk of Australian wool is produced by shearing live sheep. Approximately six per cent of the wool produced in Australia, however, is obtained by fellmongering, and about five per cent is exported in the skin. Wool, except the fellmongered wool, is sold in the grease. As a result of an extensive study, it was found that the average clean weight of wool is 46.15 per cent of the greasy weight. For this reason, the usual figure used in estimating the equivalent of greasy wool is 2.16 lbs. (0.98 kgm.) of the greasy to 1 lb. (0.45 kgm.) of the scoured wool (Carver, 1939).

The average weight of the fleece that may be obtained from each head varies from year to year, and it is also dependent on the locality where the sheep is raised. For instance, in New South Wales it was observed that sheep raised in the different sections of the

country yielded varying amounts of wool. The figures obtained in 1937-1938 were as follows (Carver, 1939):

SECTION OF COUNTRY	WOOL PRODUCED	
	Sheep	Lamb
	kgm.	*kgm.*
Tablelands	3.86	0.93
Western slopes	3.82	1.19
Plains	4.16	1.40
Western division	4.62	1.66

It has been observed also that the wool produced on the tablelands had the highest yield of scoured wool. Again, from figures obtained from the 1937-1938 wool clip in the different states visited, it was revealed that, on the whole, New South Wales produced more wool per animal than the other states. The figures obtained may be seen in the following table (Carver, 1939; Clark, 1939; and Gawler, 1939):

STATE	WOOL PRODUCED	
	Sheep	Lamb
	kgm.	*kgm.*
Victoria	3.69	0.97
New South Wales	4.11	1.30
Queensland	3.54	—

The lambing percentage has also been observed to vary in different places. Variations in seasonal conditions and availability of fodder and water have been observed to be the most important factors that cause fluctuations in the proportion of ewes mated and the lambs dropped. In Victoria, the lambing percentage observed in 1937 was 83.5 (Gawler, 1939). In New South Wales that year, it was only 67.4 per cent, but in 1938 the lambing percentage observed in this state was 71.1 (Carver, 1939).

Swine. Pig raising was previously considered only as an adjunct of dairying, but at present it is rapidly becoming popular as a result of efforts that are being exerted to encourage the establishment of pig farms. There is a general belief in Australia that the feeding of pigs should depend almost entirely on a large supply of milk, since very little use is made of the pig for the disposal of grains and grain by-products. For these reasons, the pig industry of Australia has not enjoyed the same status as the other primary industries. In 1937-1938, there were only about 1,100,000 pigs in the entire Commonwealth, or 0.16 head per capita of human population. New South Wales, Victoria, and Queensland are the biggest pig producing states in Australia.

Very little pork is eaten in Australia, most of their produce being exported to the United Kingdom. According to 1938 estimates, only about 7.58 lbs. (3.45 kgms.) of fresh pork a year is the average per capita consumption in Australia. Including bacon and ham, the average consumption amounted to about 18 lbs. (8.19 kgms.) compared with 21 lbs. (9.55 kgms.) in New Zealand, 62 lbs. (28.20 kgms.) in Canada, and 55 lbs. (25.0 kgms.) in the United States. The bacon and ham produced in Australia are exported largely to the United Kingdom, Pacific Islands, and the Far East.

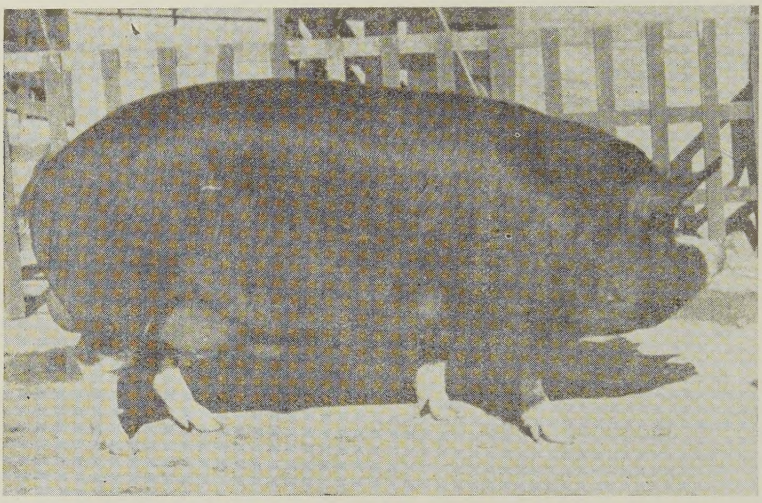

Fig. 4.—"Tipperary Canadian Rufus," the champion Berkshire boar and winner of the English National Pig Breeders' Medal for the best Berkshire pig, Royal Agricultural Show, Sydney, 1940. Courtesy of Mr. Graham F. Shirley, owner of "Camelot Stud," Penrith, New South Wales.

The frozen pork trade of Australia being largely with the United Kingdom, the market needs of the latter country are the deciding factors in the types of pigs that are raised. Having considered the conditions in the United Kingdom, the Australian farmers are now encouraged to raise baconers. For this purpose, both the Berkshire (fig. 4) and the Tamworth are considered ideal breeds for the farmers. The Berkshire, although a dual-purpose breed, has been found to be adapted to the climatic conditions of Australia. The Tamworth, a bacon type, has been successfully crossed with Berkshire, and pigs with good length and depth in the body have been obtained. The "Camelot" Stud Farm in Penrith, however, raises the Canadian type of Berkshire (fig. 5), and these are exactly of the bacon type.

These pigs are becoming more and more popular throughout the Commonwealth. Large Whites are also popular for bacon production. There are other breeds like the Poland China and the Yorkshire, but these are not popular as they do not produce the ideal type of pigs for export purposes.

Minor classes of livestock. Of the other classes of livestock raised in Australia, goats lead in number, and mules and donkeys follow. Camels are used for travel over the desert areas of the country. In the raising of goats, some attention is being devoted to the production of mohair. For this purpose, Angora goats are gradually

Fig. 5.—"Camelot Canadian Susette 10th," the reserve champion sow, Royal Agricultural Show, Sydney, 1940. Courtesy of Mr. Graham F. Shirley, owner of "Camelot Stud," Penrith, New South Wales.

increasing in number. Goats are more numerous in Queensland than in the other states, and it is even said that they are becoming a nuisance in some holdings. In 1937, Australia had only 84,600 goats, 11,900 mules and donkeys, and 3,000 camels.

Pasture grasses. The pastures of Australia are rich in both temperate and tropical grasses. In addition to such forage crops as oats, barley, lucerne (alfalfa), and clover, the native pastures have grasses that are typical of the tropics. In Queensland, where a great mixture of these grasses may be found in the pastures, the grasses represented, among other kinds, are those belonging to the genera *Andropogon, Cynodon, Paspalum, Panicum, Rottboellia, Sorghum,* and *Chrysopogon.* Cogon (*Imperata*), which is locally called

"Blady Grass", and "Spear Grass" (*Meteropogon*) are also found. Where typical tropical conditions exist, the outstanding grass from a dairying point of view is the Para Grass (*Panicum barbinode* Trin.). The other grasses that have been found useful include various species of *Paspalum* (*P. paniculatum, P. conjugatum* Berg., *P. dilatatum*), Kikuyu Grass (*Pennisetum clandestinum*), Rhodes Grass (*Chloris gayana*), and Common Couch Grass (*Cynodon dactylon* [Linn.] Pers.) (White, 1930).

Because a considerable portion of Australia's revenue is derived from her pastoral industry, much attention is being paid to the care and the improvement of her pastures. The carrying capacity of the pastures has been increased over fifty per cent through the use of fertilizers for top-dressing, the conservation of water, and wise use for grazing. In order to encourage the farmers to use fertilizers on their pastures, the Commonwealth Government pays them a subsidy of 10 shillings (₱3.25) per ton of fertilizers used, provided that the amount used is not less than half a ton or more than ten tons on any one farm. In New South Wales alone, the farmers received about £32,000 (₱208,000) in 1937-1938 (Carver, 1939).

For some years now, exotic pasture plants have been tried under different Australian conditions. As a result of this work, both grasses and legumes that show promise of winter growing have been introduced and are now under observation. Forage grasses that have been observed to remain leafy and green during the dry, hot months have also been introduced.

The control of weeds in the pastures is also being studied very carefully. Experiments are being conducted to control weeds by rotation of crops and other cultural methods, by the use of weed poisons, and by insects. Encouraging results are being obtained in the use of the lantana bug, *Teleonemia scrupulosa* Stal., in the control of lantana. Corn cob ashes spread on nut grass (*Cyperus rotundus* Linn.) areas have been observed to control this weed to a certain extent. Arsenic sprays of weak concentration have been found to penetrate the roots to a depth of about ninety centimeters and kill the skeleton weed, *Chodrilla juncea* (Julius, Rivett, and Richardon, 1939).

Livestock diseases. One of the principal reasons Australia should be a great livestock country is her freedom from many of the serious diseases and parasites that cause considerable losses in other livestock countries. Rinderpest is not known; there is no foot-and-mouth disease, glanders, sheep scab, or other serious disease. In

New South Wales, the passage of the Stock Disease Act in 1923 helped considerably in the control of diseases. This Act provides that "certain diseases are made notifiable, and necessary powers are provided for the inspection of stock and for the detention, seizure, treatment, quarantine, and destruction of diseased stock." (Carver, 1939). The other states of the Commonwealth have similar laws.

The biggest problem that confronts the cattle raisers of Queensland and New South Wales is the eradication of cattle tick which first gained access to New South Wales in the early years of the present century. Through strict quarantine regulations, however, the infestation in New South Wales has been confined to a small area in the northern part of the state. Large sums of money have been spent annually in this work. This expense, which amounted to as much as £150,000 (₱975.000) annually, is shared by the Commonwealth Government and the states of Queensland and New South Wales. In addition, the Commonwealth Government in 1937-1938 appropriated a further grant of £25,000 (₱162,000) for the construction of dips for tick eradication. Private dips are also constructed. The movement of cattle is controlled and stock is dipped regularly within areas that have been selected for tick eradication. The coordination of this work in New South Wales and in Queensland is facilitated by the Cattle Tick Control Commission created in 1926 (Carver, 1939).

Swine fever broke out in New South Wales in 1928. In order to compensate for pigs that have been condemned and for carcasses condemned in slaughter houses as unfit for human consumption, the Swine Compensation Act was passed. To provide funds for this, swine duty stamps are sold. These stamps are affixed to a register kept in slaughter houses to indicate the number of pigs slaughtered.

Research work for the maintenance of animal health is being undertaken under the supervision of the Commonwealth Council for Scientific and Industrial Research in co-operation with the State Departments of Agriculture. Researches are being conducted principally on pleuropneumonia and mastitis in cattle, and on diseases and parasites affecting sheep, like caseous lymphadenitis, foot rot, and the effect of various drugs on stomach worms (*Haemonchus contortus*) of sheep. In addition to funds provided for by the Commonwealth Government for this work, the Australian Pastoral Research Trust, the Australian Wool Board, the Australian Dairy Cattle Research Association, and the Queensland Government have given generous financial assistance (Julius, Rivett, and Richardson, 1939).

SUMMARY

1. The favorable climate and the excellent pastoral conditions of Australia make this country a prëeminent livestock country. Prolonged droughts, however, constitute the worst menace to the livestock industry.

2. Australia raises fine horses that are highly valued for military purposes.

3. Cattle is raised in all states of Australia, but Queensland leads all the other states. Shorthorn and Hereford cattle predominate in the country. Australia exports a considerable amount of both frozen and chilled beef and mutton. Most of these exports go to the United Kingdom.

4. In 1937-1938, the over three million cows in Australia averaged 1,362.7 liters of milk per head. Victoria is the most important dairy state of Australia. To encourage further production, efforts are being exerted to increase the local consumption of butter and cheese in the Commonwealth.

5. Australia is the premier sheep producing country in the world. The principal breed of sheep raised is the Merino. Long-wooled breeds are also becoming popular. The Corriedale is claimed to be well suited to the hotter and drier areas of the Commonwealth.

6. Very little pork is eaten in Australia. The Australian farmers are encouraged to raise baconers as the other types do not satisfy the demands of the export trade.

7. The pastures of Australia are rich in both temperate and tropical grasses. Because a considerable portion of Australia's revenue is derived from her pastoral industry, a great deal of attention is paid to the care and improvement of her pastures.

8. The absence of many transmissible and parasitic diseases that cause considerable losses to livestock in other countries has resulted in the rapid development of the livestock industry in Australia. The biggest problem confronting the cattle raisers of Queensland and New South Wales is the eradication of cattle ticks, which are being rapidly controlled by strict quarantine and dipping regulations.

LITERATURE CITED

CARVER, S. R. 1939. The Official Year Book of New South Wales, 1937-1938: 1-1035p. Sydney: Thomas Henry Tennant, Acting Government Printer.

CLARK, COLIN. 1939. Queensland Year Book, No. 3: xv + 366 p. Brisbane: David White, Government Printer.

GAWLER, O. 1939. Victorian Year Book. vi +609 p. Melbourne: T. Rider, Government Printer.

JULIUS, G. A., DAVID RIVETT, and A. E. V. RICHARDSON. 1939. Thirteenth Annual Report of the Council for Scientific and Industrial Research. 1–110. Canberra: L. F. Johnston, Commonwealth Government Printer.

WHITE, C. T. 1930. Queensland Pastures. Handbook for Queensland: 1–131. Plates I-XV, Brisbane, A. J. Cumming, Government Printer.

WILSON, ROLAND C. 1939. Official Year Book of the Commonwealth of Australia, No. 32 xxxii + 990 p. Canberra: L. F. Johnston, Commonwealth Government Printer.

STUDIES ON THE FOOD OF 112 FAMILIES OF LABORERS OF THE PHILIPPINE LUMBER MANUFACTURING CO., CATABANGAN, RAGAY, CAMARINES SUR [1]

F. O. Santos and N. A. Pidlaoan

Of the Department of Agricultural Chemistry

Catabañgan is a barrio of Ragay, Camarines Sur, on the northeast coast of Ragay Gulf. The life of this barrio depends chiefly on the Philippine Lumber Manufacturing Company. The mill site and the village where the laborers live cover about seventeen hectares.

The method employed (the inventory method, Morey, 1933), the apparatus used in the collection of data, and the standard used in the calculation of man units were the same as those used by Santos, Villanueva, and Silva (1936), Santos (1939), Gutierrez and Santos (1938), Santos and Demeterio (1939), and Santos and Hamoy (1940). The proximate analyses of the food materials were taken from the same sources. The actual collection of data was made by the junior author from April 4 to 25, 1940. He was helped by two women living in the locality—one, a teacher, and the other, a junior student in pharmacy.

OBSERVATIONS

The families investigated were of laborers with incomes of from ₱0.80 to ₱1.20 a day. The laborers were given free quarters, light, water, and fuel by the company. There was a hospital where the laborers and their families were given free medical treatment. Athletics were encouraged.

A commissary store operated by the company served to maintain reasonable prices for primary necessities, and there were several other stores maintained by private individauls. Owing to proximity to a fishing ground, fish was very cheap.

Although the workers came from different regions of the Philippines and Ragay is in a Bicol province, Tagalog was the prevailing language.

---

[1] Experiment Station contribution, No. 1410. Part of the expense of this investigation was defrayed by a grant-in-aid from the National Research Council of the Philippines. Read before the Los Baños Biological Club, December 12, 1940.

SUMMARY

1. The average number of persons in a family was 4 with a range of from 2 to 11. There were 507 persons in all: 168 men and 139 women over 14 years old, 5 men and 6 women over 60. The average weight of 168 men over 14 years of age was 54 kilos. The heaviest man weighed 77, and the heaviest woman, 75 kilos.

2. All except one family had three meals a day.

3. The cost of daily food per man unit ranged from 7 to 37 with an average of 16 centavos.

4. The most common food materials eaten besides rice and bread (pan de sal) were dried and fresh fish (mostly mackerel, *Rastrelliger brachysomus,* and anchovy, *Stolephorus commersonii*), "bagoong", gabi leaves, coconut milk, green jack fruit, bananas, tomatoes, and onions. Pork was usually eaten on Sundays and after pay days. Canned milk, usually the Alpine brand, was often used by families with nursing children.

5. Eighty-six per cent of the families used coffee with sugar in the morning. Night guards and overtime workers usually had coffee at supper. Twenty-seven per cent of the families ate bread at breakfast.

6. Of the 112 families, 51 per cent had an average daily man unit protein intake of 70 grams or over; 85 per cent, a carbohydrate intake of 350 grams or over; 79 per cent, a caloric intake of 2000 or over; and 36 per cent, a fat intake of 30 grams or over.

7. The average intake per man unit per day was: proteins, 75 grams; fats, 29 grams; carbohydrates, 478 grams; and calories, 2513.

8. The ratios of protein calories to total calories, and protein calories to body weight were satisfactory.

9. About sixty per cent of the proteins (59.7) came from plants, and cereals alone furnished 53.7 per cent. The percentage of proteins from animals (40.3) is higher than in all the towns previously studied but still lower than the American standard for animal protein, 60.9 per cent.

10. About seventy-six per cent of the total calories (75.84) came from cereals, 7.94 per cent from meat, fish, and eggs, 0.29 per cent from milk, 7.85 per cent from fruits and vegetables, and 8.08 per cent from sweet and fatty foods. The calories from milk and sweet and fatty foods were more, whereas the calories from cereals were less than those from towns previously studied. The calories from

meat, fish, and eggs were more than in all the towns except Paoay; the calories from fruits and vegetables were more than in Santa Catalina, Pototan, and Ramain but less than in Paoay, Calabanga, and Macrohon.

11. The intakes of calcium (0.913 gram), phosphorus (2.115 grams), and iron (0.020 gram) were in general high.

12. When the amount of food eaten is compared with that of six other places previously studied, it is found that, statistically, the amount of protein is greater than in three places, lower than in one, and the same as in two; fat is higher than in four and the same as in two; the amount of carbohydrates is higher than in three, lower than in two, and the same as in one; and calories are more than in three, less than in two, and the same as in one.

ACKNOWLEDGMENTS

The writers wish to thank Mr. Manuel Gochuico, General Superintendent of the Philippine Lumber Manufacturing Company, for the courtesies he extended them during the collection of the data.

LITERATURE CITED

CONCEPCION, ISABELO. 1933. Nutritional requirement of Filipinos. Jour. Philippine Islands Med. Assoc. 13: 26–40.

CONCEPCION, ISABELO. 1937. The nutritive value and cost of the Philippine Constabulary ration. Philippine Jour. Sci. 62: 89–114.

GREY, E. C. 1928. The food of Japan. League of Nations Health Organization, Geneva. 1–161.

GUTIERREZ, M., AND F. O. SANTOS. 1938. The food consumption of one hundred four families in Paco District, Manila. Philippine Jour. Sci. 66: 397–416.

LUSK, GRAHAM. 1928. The elements of the science of nutrition. 4th ed., 844 p., 46 fig. Philadelphia: W. B. Saunders Company.

MOREY, N. B. 1933. A study of the food habits and health of farm families in Tompkins County, New York. Cornell Agric. Exper. Sta. Bull. 563: 1–83.

ROSE, M. S. 1930. The foundation of nutrition. 501 p., 86 fig. New York: The Macmillan Company.

SANTOS, F. O. 1939. Studies on the plane of nutrition of families of laborers in Calabanga, Camarines Sur. The Philippine Agriculturist 27: 755–764.

SANTOS, F. O., AND J. K. DEMETERIO. 1939. Studies on the food of laborers' families in Macrohon, Leyte. The Philippine Agriculturist 28: 15–24.

SANTOS, F. O., AND P. S. HAMOY. 1940. The food of 158 families in Ramain, Lanao. The Philippine Agriculturist 28: 724–732.

SANTOS, F. O., I. E. VILLANUEVA, AND J. F. SILVA. 1936. Studies of the plane of nutrition of families of laborers in Sta. Catalina, Ilocos Sur; Paoay, Ilocos Norte; and Pototan, Iloilo. Nat. Res. Council Philippine Islands Sec. Ann. Rept. Bull. 11: 32–36.

TABLE 1

Food intake and distributions of families

FOOD INTAKE

grams	*No. of families*	*per cent*
Below 50	12	11
50–59	21	19
60–69	22	20
70–79	15	13
80–89	14	12
90 or above	28	25

FATS

grams	*No. of families*	*per cent*
Below 10	25	22
10–19	26	23
20–29	21	19
30–39	15	14
40–49	6	5
50 or above	19	17

CARBOHYDRATES

grams	*No. of families*	*per cent*
Below 350	17	15
350–449	29	26
450–549	41	37
550–649	18	16
650–749	4	3
750 or above	3	3

CALORIES

	No. of families	*per cent*
Below 2000	24	21
2000–2499	31	28
2500–2999	32	29
3000–3499	16	14
3500–3999	6	5
4000 or above	3	3

TABLE 2

Average intake per man unit per day

FAMILIES	PROTEINS	FATS	CARBOHYDRATES	FUEL VALUE
	grams	*grams*	*grams*	*Calories*
Santa Catalina	60 ± 1.69	15 ± 0.92	456 ± 11.54	2193 ± 51.34
Paoay	70 ± 1.56	25 ± 1.28	443 ± 10.38	2387 ± 49.71
Pototan	54 ± 0.37	13 ± 0.20	370 ± 2.94	1831 ± 11.95
Calabanga	70 ± 1.01	33 ± 1.11	564 ± 6.78	2895 ± 35.54
Macrohon	76 ± 1.94	21 ± 1.02	420 ± 8.33	2223 ± 44.38
Ramain	99 ± 1.47	20 ± 0.54	592 ± 7.20	3032 ± 38.18
Catabañgan	75 ± 0.72	29 ± 1.21	478 ± 5.07	2513 ± 25.13
	DIFFERENCES			
C—Santa Catalina	15 ± 1.83	14 ± 1.52	22 ± 12.61 (x)	320 ± 57.16
C—Paoay	5 ± 1.72 (x)	4 ± 1.76 (x)	35 ± 11.53	126 ± 55.69 (x)
C—Pototan	21 ± 0.81	16 ± 1.22	108 ± 5.86	682 ± 27.82
C—Calabanga	5 ± 1.24	(–) 4 ± 1.64 (x)	(–) 86 ± 8.46	(–) 382 ± 43.52
C—Macrohon	(–) 1 ± 2.07 (x)	8 ± 1.58	58 ± 9.75	290 ± 51.00
C—Ramain	(–) 24 ± 1.63	9 ± 1.32	(–) 114 ± 8.80	(–) 519 ± 45.70

(–) — against Catabañgan.
(x) — insignificant.

TABLE 3

Comparative food intake per kilo body weight and calories from proteins

	PC/TC	P/KBW	C/KBW
	per cent	*grams*	*calories*
Santa Catalina, Ilocos Sur	11.2	1.25	46
Paoay, Ilocos Norte	12.0	1.40	48
Pototan, Iloilo	12.0	1.08	37
Calabanga, Camarines Sur	9.9	1.35	56
Macrohon, Leyte	14.0	1.47	43
Ramain, Lanao	13.4	1.87	57
Catabañgan, Camarines Sur	12.1	1.59	54
American-medium work (Atwater *cited by* Lusk, 1928)	15	1.79	49
Japanese (Grey, 1928)	13.2	1.78	53

TABLE 4

Percentage distribution of calories

	CEREAL GRAINS	MEAT, FISH, EGGS	MILK, AND DAIRY PRODUCTS	FRUITS AND VEGETABLES	SWEET AND FATTY FOODS, ETC.
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
Sta. Catalina, Ilocos Sur	89.25	5.31		4.19	1.25
Paoay, Ilocos Norte	78.15	10.90	0.25	8.78	1.92
Pototan, Iloilo	90.41	5.94		2.59	1.06
Calabanga, Camarines Sur	79.40	4.33	0.05	13.31	2.92
Macrohon, Leyte	79.95	6.70	0.08	10.32	2.95
Ramain, Lanao	92.85	5.38	0.00	1.75	0.02
Catabañgan, Camarines Sur	75.84	7.94	0.29	7.85	8.08
American (Rose, 1930)	30	15	13	15	27
Japanese (Grey, 1928)	66	13		15	6
North Chinese (Wu, *cited by* Concepcion, 1933)	72	6.8	0.06	8.7	12.6

EFFECTS OF CERTAIN CRYPTOTROPHIC ELEMENTS UPON THE GROWTH AND YIELD OF UPLAND RICE[1]

ESTEBAN Y. CASTILLO

WITH ONE TEXT FIGURE

For upland rice when grown on Lipa clay loam, Topacio (1938) obtained the best results from the application of 5.6 grams of ammonium sulfate per pot. The effects upon the growth and yield of rice of the addition of certain cryptotrophic, or secondary essential, elements to the soil treated with ammonium sulfate were studied.

Review of literature

Roxas (1911) found that $MnSO_4$, at the concentration of M/1000, had a favorable influence upon the growth of rice plants. Jimenez (1925) found that at the concentration of 0.22 per cent (22 grams of $MnSO_4$ per kilogram of soil in a pot), this salt proved seemingly beneficial to the rice plants. At higher concentrations, however, $MnSO_4$ was harmful.

Nagaoka (1903, 1906) showed that the application of 50 kgm. of $MnSO_4$ per hectare increased the yield of rice more than 33 per cent at the first harvest, 16 per cent at the second, and only slightly at the third. He obtained a reduced yield, however, the fourth year, and ascribed it probably to the increase in the acidity of the soil. Aso (1907) obtained an increased yield of 41.8 per cent above the first crop. When a similar application of $MnSO_4$ to the same soil was made the following year, the increase of yield amounted to only about two per cent.

At low concentrations, boron, supplied as $Na_2B_4O_7$, was also found beneficial to the rice plant. Roxas (1911) found that at M/100,000, this salt had a favorable influence upon the growth of rice plants. Tokuoka and Morooka (1936) obtained good growth of rice and the yield of grain was increased by 22.5 per cent when boron was added to loam soil in pots at the rate of 0.02-2 p.p.m. But boron was toxic to the rice plants at 40 p.p.m., retarding their growth in height, tillering, and heading.

---

[1] Experiment Station contribution No. 1411. Prepared in the Department of Agricultural Botany under the direction of Professor Rafael B. Espino.

Roxas (1911) noted that zinc sulfate, at M/1,000, had a favorable influence upon the growth of rice in pot culture. Tokuoka and Morooka (1938) found that zinc at a concentration below 1000 p.p.m. in the soil and 0.5 p.p.m. in the culture solution hastened the growth of rice plants and increased the yield of grains. They noted, however, that zinc applied in larger amounts was harmful as it checked the growth of rice.

Roxas (1911) found that Cu at M/1000 had injurious effects upon the growth of rice plants, but that half this concentration was beneficial.

Tokuoka and Morooka (1938) noted that Cu, in complete culture solution, applied at a concentration below 20 p.p.m. increased the yield of rice grain, but above 20 p.p.m. the yield decreased. They also observed that Cu at 100 p.p.m. gave no yield of rice grain, and at 200 p.p.m., all plants died twenty-four days after application. The best application of Cu for rice in culture solution was found to be from 0.005 to 0.01 p.p.m., which gave a very good yield of grain. Harrison and Ayyar (1917) reported a marked increase in the yields of rice from the application of a small amount of copper sulfate in irrigation water.

It appears that cryptotrophic, or secondary essential, elements are needed by plants in very small amounts. The quantities of these substances to apply are computed on the basis of molar concentration, parts per million, percentage, pounds per tree (or three-square), pounds per acre, and kilograms per hectare.

In this work a number of factors or conditions seem to interfere with the feasibility of the comparison of results from treatments. The specific or varietal differences of the plants employed make accurate comparison difficult. Differences of weather conditions may bring about different results. Moreover, the cryptotrophic elements originally present in the soil have not been determined; only the amounts of the cryptotrophic elements added to the culture media are known.

Objects of this study

The objects of this study were (*a*) to determine the comparative effects of manganese, boron, zinc, and copper, when used singly or in combination, upon the growth and yield of upland rice grown in Lipa clay loam treated with ammonium sulfate, and (*b*) to determine whether or not the improved growth and increased yield derived from the application of ammonium sulfate can further be improved by application of cryptotrophic elements.

Time and place of this study

This study was conducted in the experimental yard of the Department of Agricultural Botany from November 30, 1938, to March 5, 1940.

MATERIALS AND METHODS

Soil

Lipa clay loam was taken from an abandoned lot behind the Administration Building of the College of Agriculture. It was pulverized, sifted, and mixed thoroughly before being used. Eighteen kilograms of air-dry soil were put in each empty gasoline tin and used as the culture pot. Chemical analysis of a similar soil showed that it contained 0.00279 per cent available P_2O_5, 0.02228 per cent available K_2O, and 0.00264 per cent available nitrogen. In pot culture experiments, Enrile (1938) and Talamisan (1938) found that similar soil contained enough K_2O and P_2O_5 but was very deficient in N for upland rice.

Plant

Upland rice, variety Inintiw, was used. The seeds, obtained from the Department of Agronomy, were soaked in water for twenty-four hours and planted in pots, ten seeds to each pot. They soon germinated, and the seedlings were finally thinned to two plants per pot. Only healthy and apparently uniformly well developed plants were used in all experiments.

Cryptotrophic elements and fertilizer

Cryptotrophic elements. The cryptotrophic, or secondary essential, elements used were manganese as $MnSO_4$, boron as $Na_2B_4O_7$, zinc as $ZnSO_4$, and copper as $CuSO_4$. Separate stock solutions of these salts at the concentration of M/100 were prepared. To insure accurate measurements and a good spread in the soil, each salt was applied in the form of solution. With a pipette, the desired amounts of the stock solutions were measured and applied to the pots singly or in certain combinations when the plants were ten days old.

In the first set of culture (table 1), each salt was tried at the rates of 0.0058, 0.0116, 0.0232, and 0.0343 gram per pot (equivalent respectively to 1, 2, 4, and 6 kgm. per hectare). Owing to the good growths obtained from the two higher concentrations, another set of cultures was conducted with three higher concentrations. In the latter set the cryptotrophic elements were each tried at the rates of 0.0058, 0.0116, 0.0232, 0.0343, 0.0696, 0.1392, and 0.2784 gram per

pot with the latter three concentrations equivalent respectively to 12, 24, and 48 kgm. per hectare.

The amounts of the cryptotrophic elements found most promising for upland rice in the first two trials were tried again singly and in certain combinations.

Fertilizer. Based on the finding of Topacio (1938), ammonium sulfate was added to the cultures when the plants were three days old at the uniform rate of 5.6 grams per pot. With the exception of cultures I and II, the rest of the cultures each received cryptotrophic elements as well as 5.6 grams of ammonium sulfate. Culture I contained Lipa clay loam only, whereas culture II received 5.6 grams of the nitrogenous fertilizer but no secondary essential elements.

Care of culture

All the cultures were exposed to sunlight and rain. They were watered only moderately to avoid the unnecessary leaching of nutrient solutions from the pots and the subsequent loss of the secondary essential elements applied. Weeding and cultivation were done whenever necessary, and destructive insects and other organisms were killed or driven away as soon as discovered.

EXPERIMENTS AND RESULTS

Culture series

Two series of experiments were conducted; each consisted of two sets of cultures. The two series are here designated as (*a*) single cryptotrophic elements series and (*b*) mixed cryptotrophic elements series.

Single cryptotrophic elements. This series consisted of two sets of cultures conducted at two different times. The first was started on November 30, 1938, and consisted of eighteen different cultures, each in triplicate. The treatments and the results obtained are recorded in table 1.

The second set consisting of thirty triplicate cultures was begun on May 26, 1939, and harvested on September 17, 1939, at the age of 113 days. The treatment of the cultures and the data obtained are given in table 2. Figure 1 shows the plants 98 days after seeding.

Mixed cryptotrophic elements. The first set was started on October 16, 1939, and consisted of seventeen triplicate cultures. On January 21, 1940, the cultures were harvested (table 3). The second set, a repetition of the first of this series, was started on Novem-

ber 17, 1939, and consisted also of seventeen triplicate cultures. On March 5, 1940, the cultures were harvested (table 4).

Criteria of results

Three criteria of results were employed—the height of top at harvest, the mean air-dry weight of straw, and the mean weight of grain.

Mean height of top. The plants were measured at the time of harvest from the base of the stem to the tip of the tallest leaf. The

Fig. 1.—Rice plants 98 days old. Cultures I, soil only; II, control; III to IX, with varying amounts of $MnSO_4$; and X to XVI, with varying amounts of $Na_2B_4O_7$. Cultures XVII to XXIII, with varying amounts of $ZnSO_4$; and XXIV to XXX, with varying amounts of $CuSO_4$. Grown from May 26 to September 17, 1939. Photographs by the Photographic Division, College of Agriculture.

data obtained from replicated cultures were averaged and standard errors of the mean determined by the usual method.

Mean weight of grain. The panicles of the rice plants in each pot were placed in a paper bag, labeled, and dried in the sun. Then the grains from each pot were threshed by hand and weighed. The weights taken included both full and empty grains. The data obtained from replicated cultures were averaged, and the corresponding standard error of the mean was determined.

Mean dry weight of straw. After the grains, the top was next harvested by cutting the culms. The top from each pot was wrapped in paper, tied, labeled, and dried in the sun. When sufficiently dried, the straw from each culture was weighed. The data obtained from similar cultures were averaged, and the standard error of the mean was afterward computed.

DISCUSSION OF RESULTS

Effects of cryptotrophic elements used singly in varying amounts

Manganese. In table 1, cultures III to VI were each statistically compared with culture II, and the results showed that only culture V, which received 0.0232 gram of $MnSO_4$, was significantly better than culture II in straw and grains.

In table 2, cultures III to IX, which received varying amounts of $MnSO_4$, were each compared with culture II, the control. The results showed that in yield of straw, cultures III to VIII were each better than II. In yield of grains, however, significantly better results than those from II were obtained from IV, V, and VI; culture V, which received 0.0232 gram of $MnSO_4$, was apparently the best.

Since in the two trials, culture V was the best in regard to height of top, yield of straw, and yield of grains, this culture might really be the best.

When culture V was, however, statistically compared with any of the other cultures (III to VI in table 1 and III to IX in table 2) that received $MnSO_4$, the differences in yields of straw were all insignificant in the first trial, whereas in the second trial, the differences, although significant with III, VIII, and IX, were insignificant with IV, VI, and VII. These results seem to indicate that under the conditions of the experiments, applications of $MnSO_4$ at the rates ranging from 0.0116 to 0.0696 gram per pot to Lipa clay loam for upland rice had almost the same effects upon the production of straw.

In grain production, however, culture V was significantly better than III and IV in the first trial, and also better than the cultures from III to IX in the second trial. In other words, the only insignificant difference in yield of grain was found in the first trial with culture VI, which received 0.0348 gram of $MnSO_4$, the highest in that set of cultures. Therefore, in grain production, culture V, which in addition to 5.6 grams of sulfate of ammonia received 0.0232 gram of $MnSO_4$, may probably be considered the best in the two sets of cultures.

Boron. In mean weight of straw (table 1), culture VIII was the highest among the boron-treated cultures. Its yield of grains, however, was accidentally the lowest. This culture could not, therefore, be considered as the best in the lot. In height and in yields of grains, IX and X were better than VIII, with IX producing apparently more grain than X. When statistically compared, however, no significant difference was found. Therefore, for grain production, pot cultures of rice supplied with $Na_2B_4O_7$ at rates ranging from 0.0058 to 0.0348 gram per pot were statistically equally effective.

Healthy rice plants were also produced in the second set of cultures supplied with varying amounts of $Na_2B_4O_7$ (fig. 1). Table 2, however, reveals that cultures XI, XII, and XIII produced taller plants, more straw, and heavier yields of grains than any of the other boron-treated cultures. The data further show that of these three cultures, XII, which received 0.0232 gram of $Na_2B_4O_7$ per pot, had the tallest rice plants, produced the highest mean dry weight of straw, and gave the highest yield of grain in the lot.

Culture IX (table 1) and culture XII (table 2) gave the highest yield of grain. Each of these two cultures contained 0.0232 gram of $Na_2B_4O_7$ per pot. Moreover, when compared with the control, or culture II, these two cultures were significantly much better in yields of grain. It may, therefore, be concluded that of the rates of application of $Na_2B_4O_7$ ranging from 0.0058 to 0.2784 gram per pot the 0.0232 gram application is the best.

Zinc. In height, mean dry weight of straw, and yield of grain, cultures XI and XII in table 1 appeared better than the rest of the $ZnSO_4$-treated cultures. When statistical comparisons were made in terms of yields of straw and of grain, not only was the difference between these two cultures insignificant but, with the exception of one case, their differences from other cultures that received $ZnSO_4$ were all insignificant.

When the yield of grain was compared with the control (culture II), the difference in favor of XI or XII was significant. The difference between the control and any of the other $ZnSO_4$-treated cultures was insignificant (table 1). Applications of $ZnSO_4$ to Lipa clay loam at the rates of 0.0058 and 0.0116 gram per pot were found to be the most promising for upland rice. At higher rates, $ZnSO_4$ was not so beneficial to the plant.

In the second trial, a slightly different trend of results was obtained. When comparisons between the control and any of the

$ZnSO_4$-treated cultures were made, more significant differences in the yield of grain and of straw were seen (table 2). But two cultures, XVII and XVIII, produced taller plants, more straw, and more grains than any of the other cultures that were treated with slightly greater amounts of the cryptotrophic elements (table 2). Therefore, applications of $ZnSO_4$ to the soil at the rates of 0.0058 and 0.0116 gram per pot were again the most promising for upland rice.

Copper. In yield of grain (table 1), culture XVII appeared to be the best among the four cultures treated with $CuSO_4$. This culture received 0.0232 gram of $CuSO_4$ per pot. As the amount of $CuSO_4$ was increased or decreased beyond 0.0232 gram per pot, the yields of straw and of grain relatively decreased. In the second trial (table 2), XXV and XXVI appeared to have produced more straw and more grain than any of the other $CuSO_4$-treated cultures. These two cultures appeared to be the best in the lot.

In yield of grain, the difference between cultures XXV and XXVI was insignificant. Neither was there a significant difference between either of these two cultures and XXIV, XXVII, or XXVIII. Significant differences were noted with XXIX or XXX. Under the conditions of this experiment, pot cultures treated with $CuSO_4$ at the rates ranging from 0.0058 to 0.0696 gram per pot produced no significant differences in the yields of grain. The cultures were about equally good. $CuSO_4$ applied at the rates greater than 0.0696 gram per pot decreased the yield of grain.

When compared with the control in yield of grain, the $CuSO_4$-treated cultures were, in general, statistically better. The differences were greatest between the control (culture II) and XVII or XVIII (table 1), and between the control and XXV or XXVI (table 2). It so happened that XVII in the first trial was identical with XXVI in the second, as they both received the same amount of ammonium sulfate and $CuSO_4$. And, since this type of culture produced the highest yield of grain in both trials and in this respect was much better than the control, it may, therefore, be considered as about the best among the $CuSO_4$-treated cultures tried. This culture consisted of Lipa clay loam to which 5.6 grams of ammonium sulfate and 0.0232 gram of $CuSO_4$ were added.

Comparisons of most promising cultures

In order to make comparison easy, the data on yield of grain and of straw from the most promising cultures (tables 1 and 2) that re-

ceived each of the cryptotrophic elements were compiled and given new culture designations (table A).

TABLE A

Experiment, November 30, 1938, to March 14, 1939

CULTURE NO.	TREATMENTS GIVEN	MEAN DRY WEIGHT OF STRAW	WEIGHT OF GRAIN
	grams	*grams*	*grams*
I	0.0232 $MnSO_4$	45.34 ∓ 9.83	45.48 ∓ 1.91
II	0.0232 $Na_2B_4O_7$	45.39 ∓ 1.42	47.51 ∓ 2.75
III	0.0116 $ZnSO_4$	47.78 ∓ 1.45	44.51 ∓ 1.05
IV	0.0232 $CuSO_4$	41.50 ∓ 6.10	46.10 ∓ 1.60
	Experiment, May 26, 1939, to September 17, 1939		
Ia	0.0232 $MnSO_4$	154.40 ∓ 11.54	97.16 ∓ 3.73
IIa	0.0232 $Na_2B_4O_7$	184.06 ∓ 13.49	88.36 ∓ 7.44
IIIa	0.0116 $ZnSO_4$	174.63 ∓ 7.98	103.66 ∓ 3.14
IVa	0.0232 $CuSO_4$	180.16 ∓ 11.45	96.93 ∓ 3.72

The mean dry weights of straw in table A were compared statistically with each other, but no significant difference was found. The weights of grain were similarly compared and no significant difference was found. Therefore, the four cultures apparently most promising for upland rice were equally effective in promoting the production of straw and of grain.

Effects of mixing cryptotrophic elements

Since the cultures that were treated with cryptotrophic elements received also ammonium sulfate, the plants produced were all rather well developed (tables 3 and 4). Therefore the comparative straw- and grain-producing power of the cultures was considered in order to select a few most promising cultures.

For this purpose, the three highest data under each of the criteria of results employed (except height of plants) were selected and indicated by H's in table 3. Similarly, the three highest values in table 4 were also selected and indicated by H's. The results showed that cultures IX, X, and XVII in table 3 and X and XVII in table 4 received the highest number of H's, indicating that these cultures were comparatively high yielders of straw and grain. Cultures IX and XIII in table 4 each received an H. Excepting IX, which produced 70.06 ∓ 3.23 grams of grain, the highest yield in table 4, the other culture (XIII), may be considered as not exceptionally good.

The selection of the most promising cultures is finally narrowed down to three, namely IX, X, and XVII. The statistics on these three cultures are given in table B.

TABLE B

Experiment, October 16, 1939, to January 21, 1940

CULTURE NO.	TREATED WITH: Ammonium sulfate	TREATED WITH: Cryptotrophic elements	MEAN WEIGHT OF STRAW	MEAN WEIGHT OF GRAIN
	grams		*grams*	*grams*
IX	5.6	Mn + Cu	42.76 ∓ 3.48	47.30 ∓ 2.92
X	5.6	B + Zn	43.23 ∓ 0.79	47.56 ∓ 2.96
XVII	5.6	Mn, B, Zn, Cu	42.90 ∓ 2.00	44.53 ∓ 1.58
Experiment, November 17, 1939, to March 5, 1940				
IXa	5.6	Mn + Cu	65.46 ∓ 6.61	70.06 ∓ 3.23
Xa	5.6	B + Zn	72.40 ∓ 2.20	61.50 ∓ 3.80
XVIIa	5.6	Mn, B, Zn, Cu	68.70 ∓ 4.44	63.63 ∓ 1.82

The data in table B showed no significant differences, indicating that these cultures were quite equally nutritive for upland rice.

Further, the three selected cultures were compared with the rest of the cultures (tables 3 and 4), and the results showed that in the first set the three arbitrarily selected cultures IX, X, and XVII had no significant differences in yields of straw and grain from V, VIII, and XVI (table 3). However, in another set of cultures, significant differences were found with V and VIII, whereas with XV and XVI the differences were all insignificant.

With such discrepancies, it would not be wise to consider V and VIII of the rank of the three selected cultures. And, since significant differences were obtained between the selected cultures (IX, X, and XVII) and any of the cultures from III to VIII and from XI to XVI, the cultures that have been arbitrarily selected may, therefore, be considered exceptionally good.

In both sets of cultures, however, with but one exception, no significant differences between the results of the three selected cultures and XV and XVI were seen. Therefore, out of the two sets of seventeen cultures each (tables 3 and 4), five most promising cultures were found, namely, IX, which received Mn and Cu; X, with B and Zn; XV, with Mn, Zn, and Cu; XVI, with B, Zn, and Cu; and XVII, with Mn, B, Zn, and Cu.

Incidentally, these five selected cultures, which appeared to be most promising for upland rice in the two lots, produced taller plants and more straw and grain than the corresponding control culture, or that which was treated only with 5.6 grams of ammonium sulfate but without any cryptotrophic elements.

In view of the foregoing discussion, it might be concluded that mixing two, three, or four cryptotrophic elements seemed to be generally more suitable for upland rice than applying the four cryptotrophic elements singly or separately.

Beneficial effect of ammonium sulfate further improved by cryptotrophic elements

Casual observation of the data in tables 1 and 2 and figures 1 and 2 revealed that in several instances cultures that received both ammonium sulfate and any of the single cryptotrophic elements used were, on the basis of height, yield of straw, and yield of grain, better than the control, which received the same amount of the fertilizer but no cryptotrophic element.

But the highest or the best yields were not obtained from any of the cultures in tables 1 and 2. For this reason, further comparative study was directed toward the data in tables 3 and 4, which revealed that mixing two, three, or four cryptotrophic elements seemed to be generally more beneficial to the rice plant than applying the four cryptotrophic elements singly or separately.

Under the criteria of results employed, yield data obtained from the cultures supplied with mixed cryptotrophic elements, especially those from the three selected cultures (IX, X and XVII), were significantly greater than those obtained from the corresponding culture II, which received no cryptotrophic element at all (tables 3 and 4).

Therefore, the beneficial effect which upland rice derived from ammonium sulfate was further improved by the addition of two or more cryptotrophic elements to Lipa clay loam.

SUMMARY AND CONCLUSIONS

1. For upland rice, application of $MnSO_4$ at the rates ranging from 0.0116 to 0.0696 gram per pot to Lipa clay loam to which 5.6 grams of ammonium sulfate had been added had about the same effects upon the production of straw. The culture which received 0.0232 gram of $MnSO_4$ may be considered the best in the two sets of cultures supplied with varying amounts of $MnSO_4$.

2. For grain production, pot cultures of rice supplied with $Na_2B_4O_7$ at the rates ranging from 0.0058 to 0.0348 gram per pot were statistically equally effective. Of the rates of application of $Na_2B_4O_7$ ranging from 0.0058 to 0.2784 gram per pot, the 0.0232 gram application may be considered the best.

3. Applications of $ZnSO_4$ to Lipa clay loam at the rates of 0.0058 and 0.0116 gram per pot were found the most promising for upland rice.

4. $CuSO_4$ applied at rates greater than 0.0696 gram per pot decreased the yield of grain. Of the $CuSO_4$ treated cultures, the most promising for upland rice grown in Lipa clay loam was one containing 0.0232 gram of $CuSO_4$ per pot.

5. Of the two sets of seventeen cultures each, the five most promising cultures were IX, which received Mn and Cu; X, with B and Zn; XV, with Mn, Zn, and Cu; XVI, with B, Zn, and Cu; and XVII, with Mn, B, Zn, and Cu.

6. Mixing two, three, or four cryptotrophic elements seemed to be generally more suitable for upland rice than applying them singly or separately.

7. The beneficial effect which upland rice derived from ammonium sulfate was improved by the addition of two or more cryptotrophic elements to Lipa clay loam.

LITERATURE CITED

ASO, K. 1907. On the continuous application of manganous chloride in rice culture. II. Tokyo Imperial Univ. Coll. Agric. Bull. 7: 449–453.

ENRILE, P. C. 1938. Should potassium sulfate be added with ammonium sulfate to Lipa clay loam for upland rice? The Philippine Agriculturist **27**: 148–167.

HARRISON, W. H., AND P. A, SUBRAHMANYA AYYAR. 1917. Notes on copper sulfate as a stimulant for rice crop. Madras Dept. Agric. Yearbook **1917**: 55–62. *Pl. 1.*

JIMENEZ, A. L. 1925. The effect of manganese compounds on the growth and yield of rice as shown by pot cultures. The Philippine Agriculturist **13**: 229–305.

NAGAOKA, M. 1903, 1906. On the stimulating action of Mn upon rice. Tokyo Imperial Univ. Coll. Agric. Bull. 5: 467–472; and 7: 77–81.

ROXAS, M. L. 1911. The effects of some stimulants upon rice. The Philippine Agriculturist and Forester 1: 89–97.

TALAMISAN, B. G. 1938. Should superphosphate be added with ammonium sulfate to Lipa clay loam for upland rice? The Philippine Agriculturist **27**: 284–301.

TOKUOKA, M., AND H. MOROOKA. 1936. The effect of boron upon the growth of rice plant. First report. Jour. Soc. Trop. Agric. 8: 12–17. Second report. Jour. Soc. Trop. 8: 211–219.

TOKUOKA, M., AND H. MOROOKA. 1938. The effect of copper on the growth of rice plant. Jour. Soc. Trop. Agric. 9: 339–349; and 10: 9–15.

TOKUOKA, M., AND H. MOROOKA. 1938. The effect of zinc upon the growth of rice plants. Jour. Soc. Trop. Agric. 10: 24–37.

TOPACIO, D. 1938. Determination of the fertilizer and fertilizer mixture suitable for an upland rice. The Philippine Agriculturist 27: 471–494.

TABLE 1

Average harvest data on upland rice grown in Lipa clay loam supplied with ammonium sulfate and kryptotrophic elements (Cultures from November 30, 1938, to March 14, 1939)

CULTURE NO.	TREATMENTS GIVEN [a]	MEAN HEIGHT OF PLANTS	DRY WEIGHT OF STRAW		WEIGHT OF GRAINS	
			Mean	Difference [c]	Mean	Difference [c]
	grams	*cm.*	*grams*	*grams*	*grams*	*grams*
I		69.72 ∓ 5.69	8.09 ∓ 1.35		6.81 ∓ 1.61	
II		91.00 ∓ 2.54	41.72 ∓ 1.28 [b]	−33.63 ∓ 1.86 sig.	31.08 ∓ 5.57 [b]	−24.27 ∓ 5.79 sig.
	Manganese					
II		91.00 ∓ 2.54	41.72 ∓ 1.28 [b]		31.08 ∓ 5.57 [b]	
III	0.0058	96.45 ∓ 1.82	39.20 ∓ 6.68	− 2.52 ∓ 6.70 insig.	29.18 ∓ 7.70	− 1.90 ∓ 9.40 insig.
IV	0.0116	100.83 ∓ 4.13	45.83 ∓ 2.96	4.11 ∓ 3.12 insig.	35.18 ∓ 3.05	4.10 ∓ 6.34 insig.
V	0.0232	102.88 ∓ 2.86	45.34 ∓ 0.83	3.62 ∓ 1.52 sig.	45.48 ∓ 1.91	14.40 ∓ 5.88 sig.
VI	0.0348	101.83 ∓ 2.13	46.38 ∓ 3.05	4.66 ∓ 3.20 insig.	41.41 ∓ 1.84	10.33 ∓ 5.86 insig.
	Boron					
VII	0.0058	99.33 ∓ 3.13	47.55 ∓ 4.33	5.85 ∓ 4.41 insig.	42.75 ∓ 1.80	11.67 ∓ 5.85 insig.
VIII	0.0116	102.50 ∓ 2.87	54.90 ∓ 4.63	13.80 ∓ 4.70 sig.	38.56 ∓ 3.17	7.48 ∓ 6.40 insig.
IX	0.0232	104.25 ∓ 3.25	45.39 ∓ 1.42	3.67 ∓ 1.91 insig.	47.51 ∓ 2.75	16.48 ∓ 6.22 sig.
X	0.0348	105.83 ∓ 3.43	49.69 ∓ 1.14	7.97 ∓ 1.70 sig.	44.50 ∓ 1.45	13.42 ∓ 5.75 sig.
	Zinc					
XI	0.0058	102.58 ∓ 3.56	44.90 ∓ 2.42	3.18 ∓ 2.73 insig.	47.43 ∓ 3.57	16.35 ∓ 3.51 sig.
XII	0.0116	104.28 ∓ 1.00	47.78 ∓ 1.45	6.06 ∓ 1.93 sig.	44.51 ∓ 1.05	13.43 ∓ 5.67 sig.
XIII	0.0232	96.83 ∓ 1.40	40.00 ∓ 2.01	− 1.72 ∓ 2.38 insig.	41.55 ∓ 4.72	10.47 ∓ 7.20 insig.
XIV	0.0348	92.11 ∓ 2.91	43.72 ∓ 1.70	2.00 ∓ 2.12 insig.	34.59 ∓ 6.24	3.51 ∓ 8.36 insig.
	Copper					
XV	0.0058	100.41 ∓ 4.29	47.30 ∓ 2.37	5.58 ∓ 2.69 sig.	39.63 ∓ 4.65	8.55 ∓ 7.25 insig.
XVI	0.0116	97.90 ∓ 3.43	47.13 ∓ 2.32	5.41 ∓ 2.64 sig.	34.34 ∓ 9.19	3.28 ∓ 10.72 insig.
XVII	0.0232	89.58 ∓ 1.94	41.50 ∓ 6.10	− 0.22 ∓ 6.23 insig.	46.10 ∓ 1.60	14.92 ∓ 5.79 sig.
XVIII	0.0348	88.70 ∓ 1.95	40.30 ∓ 0.26	− 1.42 ∓ 1.30 insig.	44.32 ∓ 2.50	13.24 ∓ 6.00 sig.

[a] Culture I contained Lipa clay loam only; each of the remaining cultures received 5.6 grams of ammonium sulfate with or without kryptotrophic elements as indicated in the table.

[b] Culture II is used as basis for comparison.

TABLE 2

Average harvest data on upland rice grown in Lipa clay loam supplied with ammonium sulfate and kryptotrophic elements (Cultures from May 26, 1939, to September 17, 1939)

CULTURE NO.	TREATMENTS GIVEN [a]	MEAN HEIGHT OF PLANTS	DRY WEIGHT OF STRAW		WEIGHT OF GRAINS	
			Mean	Difference [c]	Mean	Difference [c]
	grams	*cm.*	*grams*	*grams*	*grams*	*grams*
I		100.10 ∓ 3.75	25.93 ∓ 1.90		12.83 ∓ 2.66 [b]	
II		136.10 ∓ 1.64	105.13 ∓ 4.88 [b]	−79.20 ∓ 5.13 sig.	53.96 ∓ 3.16 [b]	−41.13 ∓ 4.13 sig.
	Manganese					
II		136.10 ∓ 1.64	105.13 ∓ 4.88 [b]		53.96 ∓ 3.16 [b]	
III	0.0058	149.93 ∓ 2.11	121.23 ∓ 6.03	16.10 ∓ 7.75 sig.	60.76 ∓ 1.92	6.80 ∓ 3.69 insig.
IV	0.0116	150.90 ∓ 2.84	145.16 ∓ 9.80	40.03 ∓ 10.90 sig.	79.46 ∓ 6.43	25.50 ∓ 7.16 sig.
V	0.0232	166.05 ∓ 1.13	154.40 ∓ 11.54	49.27 ∓ 12.48 sig.	97.16 ∓ 3.73	43.20 ∓ 4.88 sig.
VI	0.0348	149.56 ∓ 1.65	139.60 ∓ 4.00	34.47 ∓ 6.20 sig.	64.46 ∓ 3.24	10.50 ∓ 4.42 sig.
VII	0.0696	146.50 ∓ 2.44	137.56 ∓ 3.38	32.43 ∓ 5.93 sig.	63.13 ∓ 3.47	8.17 ∓ 4.69 insig.
VIII	0.1392	145.30 ∓ 2.05	120.06 ∓ 3.54	14.83 ∓ 6.02 sig.	53.66 ∓ 1.52	−0.30 ∓ 3.40 insig.
IX	0.2784	138.58 ∓ 2.57	115.16 ∓ 3.06	10.03 ∓ 5.74 insig.	52.90 ∓ 14.28	−1.06 ∓ 5.21 insig.
	Boron					
X	0.0058	145.56 ∓ 4.86	150.00 ∓ 18.36	44.87 ∓ 18.97 sig.	64.00 ∓ 4.52	8.04 ∓ 5.41 insig.
XI	0.0116	146.53 ∓ 2.08	155.16 ∓ 3.27	49.87 ∓ 5.87 sig.	74.83 ∓ 7.05	20.87 — 7.72 sig.
XII	0.0232	158.75 ∓ 1.30	184.06 ∓ 13.49	78.93 ∓ 14.31 sig.	88.36 ∓ 7.44	34.33 ∓ 8.08 sig.
XIII	0.0348	151.86 ∓ 1.17	157.73 ∓ 14.84	52.60 ∓ 15.62 sig.	74.33 ∓ 6.83	20.37 ∓ 7.55 sig.
XIV	0.0696	145.03 ∓ 3.66	155.00 ∓ 12.01	49.87 ∓ 12.96 sig.	52.10 ∓ 14.90	— 1.80 ∓ 15.19 insig.
XV	0.1392	141.81 ∓ 1.76	121.70 ∓ 8.37	16.57 ∓ 9.68 insig.	44.30 ∓ 3.59	— 9.66 ∓ 4.78 insig.
XVI	0.2784	133.28 ∓ 1.79	108.00 ∓ 6.76	2.87 ∓ 8.33 insig.	42.66 ∓ 4.22	−11.30 ∓ 5.27 insig.
	Zinc					
XVII	0.0058	160.88 ∓ 4.72	165.06 ∓ 20.02	59.93 ∓ 20.59 sig.	90.16 ∓ 5.19	46.20 ∓ 6.07 sig.
XVIII	0.0116	159.50 ∓ 1.57	174.63 ∓ 7.98	69.50 ∓ 9.35 sig.	103.66 ∓ 3.14	49.70 ∓ 4.45 sig.

[a] Culture I contained Lipa clay loam only; each of the remaining cultures received 5.6 grams of ammonium sulfate with or without kryptotrophic elements as indicated in the table.

[b] Culture II is used as basis for comparison.

TABLE 2 (continued)

CULTURE NO.	TREATMENTS GIVEN [a]	MEAN HEIGHT OF PLANTS	DRY WEIGHT OF STRAW		WEIGHT OF GRAINS	
			Mean	Difference [c]	Mean	Difference [c]
	grams	*cm.*	*grams*	*grams*	*grams*	*grams*
XIX	0.0232	156.33 ∓ 3.44	162.46 ∓ 20.31	57.33 ∓ 20.88 sig.	87.93 ∓ 7.02	33.97 ∓ 7.69 sig.
XX	0.0348	149.38 ∓ 3.06	148.73 ∓ 19.11	43.60 ∓ 19.72 sig.	77.40 ∓ 2.59	23.44 ∓ 4.08 sig.
XXI	0.0696	147.96 ∓ 1.31	143.93 ∓ 17.65	38.80 ∓ 18.30 sig.	74.73 ∓ 3.61	20.77 ∓ 4.75 sig.
XXII	0.1392	147.81 ∓ 2.17	137.73 ∓ 10.49	32.60 ∓ 11.53 sig.	67.00 ∓ 6.68	13.04 ∓ 7.38 insig.
XXIII	0.2784	136.41 ∓ 1.28	110.50 ∓ 6.73	5.37 ∓ 8.30 insig.	59.86 ∓ 2.90	5.87 ∓ 4.28 insig.
	Copper					
XXIV	0.0058	156.66 ∓ 2.05	172.23 ∓ 11.68	67.10 ∓ 12.64 sig.	88.83 ∓ 3.01	34.87 ∓ 4.36 sig.
XXV	0.0116	152.80 ∓ 3.20	180.00 ∓ 11.80	74.87 ∓ 12.76 sig.	93.26 ∓ 3.38	49.30 ∓ 4.52 sig.
XXVI	0.0232	159.31 ∓ 4.07	180.16 ∓ 11.45	75.03 ∓ 12.24 sig.	96.93 ∓ 3.72	42.97 ∓ 4.88 sig.
XXVII	0.0348	153.70 ∓ 2.86	159.76 ∓ 10.13	54.63 ∓ 11.24 sig.	92.46 ∓ 3.45	38.49 ∓ 4.67 sig.
XXVIII	0.0696	151.20 ∓ 2.89	153.40 ∓ 13.55	48.27 ∓ 14.38 sig.	87.66 ∓ 4.42	33.70 ∓ 5.43 sig.
XXIX	0.1392	146.35 ∓ 2.39	153.00 ∓ 4.06	47.87 ∓ 6.34 sig.	69.53 ∓ 2.38	13.57 ∓ 3.95 sig.
XXX	0.2784	138.70 ∓ 3.76	146.80 ∓ 8.29	41.67 ∓ 9.61 sig.	63.66 ∓ 3.07	9.70 ∓ 4.30 sig.

TABLE 3

Average harvest data on upland rice grown in Lipa clay loam supplied with ammonium sulfate and kryptotrophic elements used singly and in certain combinations
(Cultures from October 16, 1939, to January 21, 1940)

CULTURE NO.	TREATMENTS GIVEN [a]	MEAN HEIGHT OF PLANTS	DRY WEIGHT OF STRAW		WEIGHT OF GRAINS	
			Mean	Difference	Mean	Difference
		cm.	*grams*	*grams*	*grams*	*grams*
I		69.38 ∓ 1.68	6.53 ∓ 0.99		9.70 ∓ 1.95	
II		87.15 ∓ 2.40	24.60 ∓ 2.05 [b]	−18.07 ∓ 2.27 sig.	27.66 ∓ 1.73 [b]	−17.96 ∓ 2.60 sig.
II		87.15 ∓ 2.40	24.60 ∓ 2.05 [b]		27.66 ∓ 1.73 [b]	
III	Mn	101.96 ∓ 2.53	37.66 ∓ 3.34	13.04 ∓ 3.81 sig.	39.56 ∓ 1.27	11.90 ∓ 2.14 sig.
IV	B	103.15 ∓ 4.18	34.40 ∓ 2.55	9.80 ∓ 3.27 sig.	34.43 ∓ 2.28	6.77 ∓ 2.86 sig.
V	Zn	105.73 ∓ 1.81	38.33 ∓ 2.71	13.73 ∓ 3.39 sig.	41.26 ∓ 1.54	13.60 ∓ 2.31 sig.
VI	Cu	96.38 ∓ 2.56	33.26 ∓ 1.24	8.66 ∓ 2.39 sig.	35.40 ∓ 1.02	7.74 ∓ 2.00 sig.
VII	Mn + B	101.50 ∓ 2.50	37.03 ∓ 0.74	12.43 ∓ 2.17 sig.	38.93 ∓ 0.83	11.27 ∓ 1.92 sig.
VIII	Mn + Zn	97.50 ∓ 3.22	39.96 ∓ 1.89	15.36 ∓ 2.78 sig.	42.66 ∓ 1.58	15.00 ∓ 2.31 sig.
IX	Mn + Cu	101.23 ∓ 1.36	42.76 ∓ 3.48H	18.16 ∓ 4.03 sig.	47.30 ∓ 2.92H	19.64 ∓ 3.39 sig.
X	B + Zn	106.46 ∓ 1.27	43.23 ∓ 0.79H	18.63 ∓ 2.19 sig.	47.56 ∓ 2.96H	19.90 ∓ 3.34 sig.
XI	B + Cu	103.01 ∓ 2.90	38.90 ∓ 0.16	14.30 ∓ 2.05 sig.	37.30 ∓ 1.61	10.64 ∓ 2.36 sig.
XII	Zn + Cu	101.35 ∓ 2.90	39.80 ∓ 2.33	15.20 ∓ 3.10 sig.	39.26 ∓ 1.36	11.60 ∓ 2.20 sig.
XIII	Mn + B + Zn	102.11 ∓ 0.94	39.60 ∓ 2.47	15.00 ∓ 3.12 sig.	37.13 ∓ 2.91	9.47 ∓ 3.38 sig.
XIV	Mn + B + Cu	103.15 ∓ 1.17	40.53 ∓ 2.71	15.93 ∓ 3.39 sig.	38.80 ∓ 0.46	11.14 ∓ 1.78 sig.
XV	Mn + Zn + Cu	98.95 ∓ 1.34	39.83 ∓ 2.71	15.23 ∓ 3.39 sig.	41.06 ∓ 1.15	13.40 ∓ 2.07 sig.
XVI	B + Zn + Cu	102.16 ∓ 1.54	40.13 ∓ 4.05	15.53 ∓ 4.53 sig.	43.63 ∓ 3.43	15.97 ∓ 3.84 sig.
XVII	Mn + B + Zn + Cu	97.21 ∓ 3.33	42.90 ∓ 2.00H	18.30 ∓ 2.86 sig.	44.53 ∓ 1.58H	16.87 ∓ 2.34 sig.

[a] Culture I contained Lipa clay loam only; each of the remaining cultures received 5.6 grams of ammonium sulfate with Mn as $MnSO_4$, 0.0232 gram per pot; B as $Na_2B_4O_7$, 0.0232 gram per pot; Zn as $ZnSO_4$, 0.0116 gram per pot; and Cu as $CuSO_4$, 0.0232 gram per pot. These were the best rates found in the first two experiments (tables 1 and 2).

[b] Culture II is used as basis for comparison.

TABLE 4

Average harvest data on upland rice grown in Lipa clay loam supplied with ammonium sulfate and kryptotrophic elements used singly and in certain combinations
(Cultures from November 17, 1939, to March 5, 1940)

CULTURE NO.	TREATMENTS GIVEN [a]	MEAN HEIGHT OF PLANTS	DRY WEIGHT OF STRAW		WEIGHT OF GRAINS	
			Mean	Difference	Mean	Difference
		cm.	*grams*	*grams*	*grams*	*grams*
I		64.91 ∓ 1.37	12.63 ∓ 2.45		12.10 ∓ 1.15	
II		88.74 ∓ 1.17	44.93 ∓ 2.18 [b]	−32.30 ∓ 3.27 sig.	40.86 ∓ 0.95 [b]	−28.76 ∓ 1.48 sig.
II		88.74 ∓ 1.17	44.93 ∓ 2.18 [b]		40.86 ∓ 0.95 [b]	
III	Mn	96.00 ∓ 3.88	55.40 ∓ 1.09	11.47 ∓ 2.43 sig.	55.14 ∓ 3.30	14.28 ∓ 3.33 sig.
IV	B	88.60 ∓ 2.88	57.96 ∓ 5.07	13.04 ∓ 5.41 sig.	48.33 ∓ 3.41	7.47 ∓ 3.54 sig.
V	Zn	86.00 ∓ 1.41	61.43 ∓ 1.89	16.50 ∓ 2.88 sig.	53.16 ∓ 0.44	12.30 ∓ 1.03 sig.
VI	Cu	86.83 ∓ 1.67	56.90 ∓ 1.41	11.90 ∓ 2.59 sig.	50.16 ∓ 4.91	9.30 ∓ 4.99 insig.
VII	Mn + B	86.53 ∓ 1.27	65.53 ∓ 4.04	20.60 ∓ 4.59 sig.	56.86 ∓ 5.58	16.00 ∓ 5.67 sig.
VIII	Mn + Zn	92.11 ∓ 2.14	65.70 ∓ 8.82	20.77 ∓ 9.08 sig.	54.50 ∓ 2.89	13.64 ∓ 3.03 sig.
IX	Mn + Cu	99.61 ∓ 1.01	65.46 ∓ 6.61	20.53 ∓ 6.95 sig.	70.06 ∓ 3.23H	29.20 ∓ 3.86 sig.
X	B + Zn	92.16 ∓ 2.13	72.40 ∓ 2.20H	27.47 ∓ 3.11 sig.	61.50 ∓ 3.80H	20.64 ∓ 3.81 sig.
XI	B + Cu	94.55 ∓ 0.67	56.70 ∓ 4.36	13.77 ∓ 4.87 sig.	61.30 ∓ 6.80	20.44 ∓ 6.89 sig.
XII	Zn + Cu	91.16 ∓ 1.54	60.86 ∓ 4.11	15.93 ∓ 4.67 sig.	57.00 ∓ 1.04	16.14 ∓ 1.40 sig.
XIII	Mn + B + Zn	92.16 ∓ 3.54	67.13 ∓ 11.24H	22.20 ∓ 11.44 insig.	59.63 ∓ 1.67	18.77 ∓ 1.91 sig.
XIV	Mn + B + Cu	95.40 ∓ 1.86	59.93 ∓ 6.08	15.00 ∓ 6.45 sig.	58.16 ∓ 3.63	17.30 ∓ 3.76 sig.
XV	Mn + Zn + Cu	92.70 ∓ 2.37	63.13 ∓ 5.71	18.20 ∓ 6.01 sig.	60.30 ∓ 10.64	19.44 ∓ 10.67 insig.
XVI	B + Zn + Cu	89.43 ∓ 0.67	64.33 ∓ 4.21	19.40 ∓ 4.64 sig.	59.00 ∓ 8.72	18.14 ∓ 8.77 sig.
XVII	Mn + B + Zn + Cu	94.05 ∓ 1.35	68.73 ∓ 4.44H	23.80 ∓ 4.84 sig.	63.63 ∓ 1.89H	22.77 ∓ 2.04 sig.

[a] Culture I contained Lipa clay loam only; each of the remaining cultures received 5.6 grams of ammonium sulfate with Mn as $MnSO_4$, 0.0232 gram per pot; B as $Na_2B_4O_7$, 0.0232 gram per pot; Zn as $ZnSO_4$, 0.0116 gram per pot; and Cu as $CuSO_4$, 0.0232 gram per pot. These were the best rates found in the first two experiments (tables 1 and 2).

[b] Culture II is used as basis for comparison.

THE EFFECT OF PRUNING AT VARYING AGES UPON THE YIELD OF RAMAI RICE [1]

RAMON D. ROJAS

Many farmers in the Philippines believe that pruning the leaves of rice seedlings before they are transplanted will increase the yield. For the same reason, others prune vegetative plants before they flower to encourage fruitfulness. If leaf pruning really has the effect it is believed to have, it can become one of the most economical ways of increasing the yield, with the added advantage that it will provide the farmers with feeding materials for their work animals in the form of rice tops to supplement the rice straw which constitutes the main feed before the crop is harvested.

According to Copeland (1924), Abder Rahman Shaq stated that in Sind, India, the practice is to let cattle graze the tops above the water, or to trim them off with a sickle if the growth of the rice is very rank. The object of pruning is to encourage the formation of bigger ear-heads and keep down the proportion of straw to grain.

Carreon (1923)[2] determined the influence on the plant of cutting off a part of the leaves and roots of rice seedlings of different ages and found that, in general, a greater yield of grain and straw was obtained from plants treated while young than from those treated later.

Punsalan (1923)[3] worked on the effect upon the yield of rice of cutting off the leaves of upland and lowland rice varieties at different ages and found that cutting prolonged the period of flowering and maturity. This varied from 57 to 63 days after transplanting, when the leaves were cut at the base of the blade of the last leaf, and from 60 to 82 days after transplanting, when the leaves were cut at the base of the blade of the second lowest leaf. A uniformity in the date of the maturity of the plants occurred when the leaves were cut. The increase in the period of maturity of the plants varied from one

[1] Experiment Station contribution No. 1412. Prepared in the Department of Agronomy under the direction of the late Assistant Professor Vicente B. Aragon.

to fifteen days when they were cut at the base of the blade of the last leaf, and two to nineteen days when cut at the base of the blade of the second lowest leaf.

Andaya (1926)[4] reported that cutting the leaves of rice once slightly retarded the date of flowering. The time of flowering was prolonged only when the leaves of the rice plants were cut when the plants were 65 to 72 days old. He also found that the time for cutting the leaves which gave the greatest yield and had a significant difference over the other ages was when the rice plants were 37 days old. Beyond that age, a gradual decrease in yield resulted from cutting.

The objects of this work were: (*a*) to determine the relative effect upon the yield of Ramai rice of cutting off the leaves of the rice plants at different ages, (*b*) to find the age of the plants at which cutting off the leaves would give the best yield, and (*c*) to determine the influence of cutting upon the dates of flowering and maturity.

The study was started in June, 1938, and was finished in March, 1939. The cultures were planted in the lowland rice fields of the Experiment Station of the College of Agriculture.

MATERIALS AND EXPERIMENTS

Land. The soil is clay loam. According to Galvez (1936), the soil of the lowland rice fields of the Experiment Station contains 0.16 per cent nitrogen, 0.20 per cent phosphoric acid, 0.10 per cent potash, and 1.4 per cent calcium oxide.

The field with an area of 12,500 square meters was divided into five lots. Each lot was in turn subdivided into five plots, each 25 meters long and 20 meters wide, making an area of 500 square meters each. The plots were separated from each other by dikes and were numbered from 1 to 25 consecutively. There were five replications for each treatment and control. The plots were arranged in a more or less checkerboard fashion so as to minimize as much as possible the effects of soil variability.

Variety used. The seed of the Ramai rice used was obtained from the Division of the Annual Farm Crops of the Department of Agronomy of the College.

[2, 3, 4] Unpublished theses on file in the library of the College of Agriculture.

Pruning. The plants, except in the control lot, were topped before they were transplanted. Sharp knives were used to cut the leaves. Subsequent pruning of the plants was done as follows:

NO. OF PLOTS	TREATMENT
5	Before being transplanted, the seedlings were pruned to one-half their height at the age of 40 days. No subsequent cutting was made thereafter.
5	Before being transplanted, the seedlings were pruned to one-half their height and later to the last ligule of the tallest plant when 100 days old.
5	Before being transplanted, the seedlings were pruned to one-half their height and later to the last ligule of the tallest plant at 115 days of age.
5	Before being transplanted, the seedlings were pruned to one-half their height and later to the last ligule of the plants at 130 days of age.

RESULTS AND DISCUSSION

Field observations

Length of seedlings transplanted after cutting of one-half of the height. Sixteen centimeters was the average length of the cut seedlings in 100 bundles taken at random; the untopped were about twice this height.

Changes in color of the plants pruned at different ages. A few days after transplanting, the color of the control plants was very different from that of the topped. The control plants were slightly wilted, and the tips of the leaves turned yellowish; on the other hand, the pruned plants were green. Two weeks after transplanting, the plants in the control plots attained their normal green.

In general, all pruned plants appeared yellowish-green a few days after topping, but they became greener as they grew older. The plants which were pruned at the age of 130 days remained pale green until maturity.

Tendency to lodge. Even before blooming and between the first and second week after blooming, many plants in the control plots lodged. Some which had been topped earlier lodged also about two weeks after blooming, whereas only a few of those that had been

topped later lodged a few days before harvesting. Lots II and III gave a higher percentage of lodged plants than lots IV and V.

Pests and diseases. The young seedlings were attacked, to a slight extent, by the rice leaf roller, *Cnaphalocrosis medinalis* Guenée, the rice stem borer, *Schoenobius incertellus* Walker, and the rice bug, *Leptocorisa acuta* Thunberg.

When the grains were quite mature, care was taken to drive away the weavers, *Munia jagori* Martens, that occasionally flocked in the field.

The false smut of rice caused by *Ustilaginoidea virens* (Cke.) Tak. was observed in the rice field when the plants were reaching maturity. The damage caused by this disease was insignificant; only a few grains were infected by the disease in the different plots.

Blooming and maturity periods. The seed was broadcast on the seedbed on August 12, 1938, and transplanted on September 21, 1938, 40 days after planting. About the end of December, 1938, a few plants in the different plots bloomed. Nine days later, almost all the plants had bloomed.

Although the date of flowering, as affected by cutting the leaves, varied slightly, the effect on the time of maturity was not significant. In some places in the field the maturity of the plants was slightly delayed, presumably owing to too much water or to the uneven fertility of the soil. The results of the present study tally with previous records in the Department of Agronomy, showing that Ramai requires from 178 to 185 days to attain full maturity. In this study it took 182 days for the grains to mature.

Table 1 shows that the computed yield of the control lots ranged from 41.65 to 53.39 cavans per hectare. Those that were pruned once before transplanting gave a computed yield of from 41.74 to 57.02 cavans. The third treatment, in which the plants were subsequently cut to the last ligule of the tallest plant at 100 days old, or 60 days after transplanting, produced a computed yield of from 58.67 to 66.15 cavans. The fourth treatment, those that were topped at 115 days of age, or 75 days after transplanting, gave a computed yield of from 43.30 to 58.76 cavans; and those that were topped at 130 days of age, or 90 days after transplanting, produced from 35.37 to 44.91 cavans. Only in lot V, where the plants were topped at 130 days of age, was the average yield of the control plots higher than that of the treated (table 1).

Table 1 shows also that the control plots gave an average computed yield per hectare of 47.89 ± 1.34 cavans; the lots where the plants were topped before transplanting, 54.76 ± 2.48 cavans; the lots pruned to one-half the height before transplanting and to the last ligule of the tallest plants in the hill at 100 days old, 61.17 ± 1.06 cavans; the lots in which the plants were subsequently pruned at 115 days of age, 50.95 ± 2.09 cavans; and those topped subsequently at 130 days of age, 41.20 ± 1.62 cavans per hectare. Except in the last treatment (lot V), the average computed yields of all the treated plots were higher than that of the control. The results show that plants topped when relatively young gave a higher yield than plants topped when relatively old, and also than untopped plants. Probably when the rice plants are cut while young, they have sufficient time to recover, the formation of more foliage is checked, and the production of grains is encouraged. The best time to cut the leaves of rice in order to obtain the greatest yield is before transplanting and 60 days after transplanting. The cut top is a decided advantage, since it can be used as feed for work animals.

Table 2 shows that the plants topped before transplanting and with no subsequent cutting gave a computed yield higher by 6.87 cavans per hectare than the control, or an increase of 14.35 per cent. Plants subsequently topped at 100 days of age gave the highest average computed yield with an increase of 13.28 cavans per hectare over the control, or 27.73 per cent. The plants topped at 115 days of age showed a decrease in yield, although the average computed yield was still higher than the control by 3.06 cavans, or 6.39 per cent. Subsequent topping of the plants at 130 days decreased the yield to such an extent that it was even lower than the control by 6.69 cavans, or 13.99 per cent.

In table 3, the differences in yield between the control and the topped plants can be seen to vary. The yields only of lots III and V show a significant difference; lot III is higher, whereas lot V is lower than the control. When the average computed yields per hectare of the topped plants are compared, it can be seen in the same table that the differences between the yields of lots II and V, III and V, III and IV, and IV and V are significant; the earlier topping is the better.

Cutting the seedlings before transplanting at 40 days old increased the yield of Ramai, the increase having a value of ₱20.00 per hectare (table 2). The cost of pruning before transplanting to cut expenses in this lot (II) amounted to ₱0.40 per hectare. Lot III which was given subsequent cutting at 100 days of age gave an increase

LIBRARY

valued at ₱41.17 per hectare. With the cost of cutting amounting to ₱11.80 (this includes the amount of ₱0.40, the cost of cutting the leaves before transplanting), the highest net profit of ₱29.37 was obtained. The rest of the treatments, lot IV and lot V, which were cut at 115 and 130 days of age respectively, incurred losses of ₱2.56 and ₱33.74 per hectare, respectively.

SUMMARY AND CONCLUSIONS

1. This study was undertaken to determine the effects upon the yield of Ramai rice of pruning the plants at different ages of growth, the age that will respond favorably to pruning, and the influence upon the date of flowering and maturity. Four ages were considered, namely, 40, 100, 115, and 130 days.

2. Lodging occurred immediately before and after blooming in all the control plots, although the degree varied. A higher degree was observed in plots where there was more water. In plots where the plants were topped when relatively young, they lodged about two weeks after blooming, whereas in plots where they were topped when old, they lodged only just before harvesting.

3. Pruning the leaves affected slightly the dates of blooming and of maturity. The results of the present study show that Ramai requires 182 days to mature.

4. Cutting the leaves in young plants not more than 115 days after planting increased the yield in grains. Thereafter, the yield decreased. The plants pruned at 100 days of age gave the highest computed yield per hectare, 61.17 ± 1.06 cavans; the plants that were pruned (seedlings) just before transplanting and that had no subsequent topping gave the second highest average computed yield per hectare, 54.76 ± 2.48; the third highest yield was obtained in the 115 day old treatment with an average computed yield per hectare of 50.95 ± 2.09 cavans; the last treatment, which was pruned at 130 days of age was the lowest, 41.20 ±1.62 cavans.

5. The difference in yield between the 100 day old treatment (lot III) and the control (lot I) was highly significant, 13.28 ± 1.71 cavans per hectare. The same was true of the 130 day old treatment (lot V) and the 100 day old treatment (lot III), 20.97 ± 1.52 cavans per hectare. Other comparisons with significant differences are lot V and the control (lot I), lot V and the 40 day old plants (lot II), lot III and the 115 day old plants, and lots V and IV. All others were insignificant.

6. The highest computed net gain, ₱29.67 per hectare, was obtained in lot III, which was given a subsequent cutting at 100 days of age. The second, ₱21.20, was obtained in lot II, which was topped once before transplanting. The other lots incurred losses.

7. Based on the results obtained, it may be concluded that under conditions existing in Los Baños, pruning the leaves of rice at an early stage of development would be profitable, because, besides the increase in the yield, the cut tops represent an additional gain since they can be used as fresh succulent feed for work animals.

LITERATURE CITED

COPELAND, E. B. 1924. Rice. xiv + 352 p., 26 fig. London: Macmillan and Co., Ltd.

GALVEZ, N. L. 1936. Plant-food reserves in lowland and upland soils. The Philippine Agriculturist 25: 221–232.

TABLE 1

Yield of different plots of Ramai rice variety under different ages of topping

LOT NO.	PLOT NO.	TREATMENT	AGE AT TOPPING	ACTUAL YIELD PER PLOT	COMPUTED YIELD PER HECTARE	
					Yield per plot	Average
				kgm.	*cavans*	*cavans*
I	1	Control (No pruning made)	—	108.8	49.91	47.89 ± 1.34
	2			90.8	41.65	
	3			105.9	48.58	
	4			100.1	45.92	
	5			116.4	53.39	
II	6	Pruned before being transplanted to one-half the height of the seedlings. No subsequent pruning thereafter.	40 days old	124.0	56.88	54.76 ± 2.48
	7			140.2	64.31	
	8			124.3	57.02	
	9			117.4	53.85	
	10			91.0	41.74	
III	11	Pruned before being transplanted to one-half the height and later to the last ligule of the tallest plant.	100 days old	144.2	66.15	61.17 ± 1.06
	12			137.0	62.84	
	13			124.8	57.25	
	14			132.8	60.92	
	15			127.9	58.67	
IV	16	Pruned before being transplanted to one-half the height and later to the last ligule of the tallest plant.	115 days old	94.4	43.30	50.95 ± 2.09
	17			125.2	57.43	
	18			128.1	58.76	
	19			108.5	49.77	
	20			99.2	45.51	
V	21	Pruned before being transplanted to one-half the height and later to the last ligule of the tallest plant.	130 days old	97.9	44.91	41.20 ± 1.62
	22			91.2	41.83	
	23			94.2	43.21	
	24			77.1	35.37	
	25			88.7	40.69	

TABLE 2

Increase (+) or decrease (—) in yield and profit (+) or loss (—) per hectare resulting from cutting of the leaves at different ages

LOT NO.	AVERAGE COMPUTED YIELD PER HECTARE	INCREASE (+) OR DECREASE (—) DUE TO CUTTING	PER CENT INCREASE (+) OR DECREASE (—) DUE TO CUTTING	VALUE OF INCREASE (+) OR DECREASE (—) IN YIELD PER HECTARE [a]	NUMBER OF HOURS SPENT IN CUTTING THE LEAVES PER HECTARE	COST OF PRUNING [b]	GAIN (+) OR LOSS (—) PER HECTARE
	cavans	*cavans*	*per cent*	*pesos*	*hours*	*pesos*	*pesos*
I	47.89	—	—	—	—	00.40	—
II	54.76	61.87 (+)	14.35	21.30 (+)	4	00.40	20.90 (+)
III	61.17	13.28 (+)	27.73	41.17 (+)	118	11.80	29.37 (+)
IV	50.95	3.06 (+)	6.39	9.49 (+)	120.5	12.05	2.56 (—)
V	41.20	6.69 (—)	13.99	20.74 (—)	130	13.00	33.74 (—)

[a] Current price of palay, ₱3.10 per sack (44 kgm.) during harvest time.
[b] Cost of cutting at ₱0.10 per hour (man labor) under College conditions.

TABLE 3

Significance of the difference in yield of the different treatments

TREATMENTS COMPARED	DIFFERENCE IN YIELD BETWEEN TWO MEANS AND ITS PROBABLE ERROR	SIGNIFICANCE OF DIFFERENCE
	cavans	
Lot II and Lot I	6.87 ± 2.82	Slightly insignificant
" III " " I	13.28 ± 1.70	Highly significant
" IV " " I	3.06 ± 2.48	Highly insignificant
" V " " I	6.69 ± 1.72	Significant
Lot III and Lot II	6.41 ± 2.70	Insignificant
" IV " " II	3.81 ± 3.25	Highly insignificant
" V " " II	13.56 ± 2.71	Significant
Lot IV and Lot III	10.21 ± 2.46	Significant
" V " " III	20.97 ± 1.52	Highly significant
Lot V and Lot IV	9.75 ± 2.49	Significant

A STUDY ON BUDDING THE STAR APPLE WITH SPECIAL REFERENCE TO THE MODIFIED FORKERT METHOD [1]

L. G. Gonzalez and Pedro E. Gloria
Of the Department of Agronomy

WITH ONE TEXT FIGURE

Although successful results were obtained in marcotting, inarching, and cleft grafting the star apple, *Chrysophyllum cainito* Linn., no success was obtained from shield budding (Gonzalez and Songmani, 1940).

In Java, the modified Forkert method (Ochse and Van Der Brink, 1931) is used extensively for almost all kinds of fruit trees, including those which, under our conditions, have not been found easily propagated by shield budding. These include the chico, the mango, the durian, and many other kinds. As this method has not been tried here on a large scale, further tests were made to determine its adaptability to some of our important fruits under local conditions.

A method similar to the modified Forkert was used successfully by Mercado (1934) and Pacumbaba (1940) in budding kapok. This seems to be, at present, the most satisfactory way of budding Hevea rubber (Mendiola, 1931, and Aguanta [2]).

The object of this study was to test the feasibility of propagating the star apple by budding especially by the modified Forkert method.

The experiment was performed in the Pomology Nursery, Department of Agronomy, from June, 1939, to February, 1940.

MATERIALS AND METHODS

Materials

Stocks. Six hundred and seven star apple seedlings, 587 of which were about three years old and 20, one and one-half years, were used in the experiment. The three year old plants were a part of the lot used previously (Gonzalez and Songmani, 1940) in cleft grafting. The seedlings were grown from seeds collected from the

[1] Experiment Station contribution No. 1415.

[2] Aguanta, B. M. A study of vegetative buds of *Hevea brasiliensis* (HBK.) Muell.-Arg. from the standpoint of propagating by budding. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. 1929. Unpublished).

College orchard and planted about sixty centimeters apart in nursery rows one hundred fifty centimeters apart.

The three year old seedlings were, on the average, 239.44 centimeters in height and 2.7 centimeters in girth, whereas the one and one-half year old plants were 124.64 centimeters in height and 1.2 centimeters in girth.

Scions. The scions used were secured from five trees selected for the good quality of their fruit. They were from ten to twenty-five years of age and were growing in the College orchards.

Budding outfit. An improvised wooden box with a handle served as a budding kit. Included in the miscellaneous outfit were a pair of budding knives, several rolls of budding tape, a whetstone, a can of asphalt-kerosene mixture for tree-wound dressing, a preserving can with sphagnum moss for protecting the bud sticks from exposure, labels, India ink, and a few other useful materials. Strips of thin cotton cloth impregnated with a mixture of four parts resin, four parts beeswax, and one part tallow were used for tape.

The modified Forkert method. The modified Forkert method used in this experiment was adopted from that reported by Ochse and Van Der Brink (1931), who described it as follows:

"With this method the bark is not incised and for 2/3 cut off on the spot where the bud has to be inserted on the stock, as in the ordinary Forkert-method,[4] but is torn off and afterwards cut off for 2/3. This tearing off can best be done at the moment the stock is about to produce new shoots. Usually one cannot at once tear off bark enough for the insertion of the bud but one has to tear away a few strips from above downward. Care should be taken that no wood of the stock is taken away when making the wound for budding. If one makes such wounds by following the Forkert-method one always runs the risk to cut away some wood.

When cutting a bud, one should always take away some wood. This wood, however, has to be removed in such a manner that the bud is not damaged. The cutting of the bud is as a matter of fact performed in the same manner as is done for grafting with a bud, e.g., chip budding. When the bud cut in this way is inserted on the stock, it should precisely fit into the wound, just as in the case with patch-budding."

Patch budding. In patch budding a rectangular piece of bark is used with the bud included but with the woody portion attached to the scion removed. Care is taken that the growing point of the bud is not destroyed.

---

[4] Mollers Deutsche Gartner Zaitung. 1906. *Cited in* Ochse and Van Der Brink (1931).

H-budding. In the H-budding, an incision is made in the form of an "H" with the crosscut made about midway between the ends of the longitudinal cuts. All of the bud except the growing point of the shield, which remains free from pressure is placed between the two flaps and is covered above and below, making it fit well. Tying is similar to that in ordinary shield budding.

Selection and preparation of materials

Stocks. Only vigorous seedlings were selected. They were divided into comparable lots as follows:

(*1*) *Control*—This lot had 102 seedlings which received no special treatment but ordinary care. They were kept free from weeds and were cultivated from time to time.

(*2*) *Manured*—A total of 134 seedlings was in this group. They were watered and cultivated whenever necessary but not shaded.

(*3*) *Shaded*—This lot had 88 seedlings, which were watered and cultivated from time to time. A bamboo trellis was used for shade.

(*4*) *Pruned to a single stem*—In this group were 252 seedlings. All branches were pruned off, and only the main stem was left in each plant. The wound was well covered with an asphalt-kerosene mixture.

(*5*) *Balled*—In this group were 12 plants. They were planted singly in cans, their tops pruned heavily, and they were placed in the shade in the nursery.

(*6*) *Root pruned*—This lot had 19 seedlings. Two parallel trenches, 30 cm. deep and 20 cm. away from each side of the plants in the raw, were dug without further moving the plants. The trenches were covered again, the main purpose being to prune some of the roots as in balling.

Kinds of scions. Three kinds of scions were used: young, medium, and old.

Young scions were obtained from newly developed branches. They were brownish orange and the wood was quite tender.

Medium aged scions were a slightly darker brown and usually had more prominent buds than the soft wood or young scions.

Old scions were obtained from older branches. The color was almost drab. They had only a few well-formed buds.

Treatment of scions. Some of the bud sticks were given the following treatments before the buds were used:

(1) Some of the branches were defoliated two weeks before they were gathered for budding. This was for forcing the development of the buds.

(2) In a part of the experiment, the bud sticks were placed in moist sand similar to being planted as stem cuttings. They were left for a week before they were used for budding.

(3) In another lot, the buds were cut and inserted soon after the scions were collected.

In all cases, the bud sticks were kept in a can with an abundance of moist sphagnum moss.

RESULTS AND DISCUSSIONS

Adaptability to different methods of budding

Of the four methods of budding compared, the modified Forkert method gave the highest percentage of successful union, with a range of from 3.33 to 26.32 and an average of 14.95 $\pm$ 4.70 per cent (table 1). In the patch budding method, the range was from 1.13 to 1.38 with an average of 1.27 $\pm$ 0.02 per cent. With shield and H-budding, no successful union was obtained.

The main difference between the modified Forkert method and shield budding lies in the removing of the woody portion from the bud in the former and allowing it to remain in the latter. In star apple, when the woody tissue is cut, the latex comes out. On exposure to air, it coagulates and forms a plastic residue very much like rubber in consistency. This may cover the exposed cells of the bud, forming an impermeable coating that interferes with union between the bud and the stock. Where the woody tissue is removed, the free flow of latex is obviated, and while the possible area of union is limited to the base of the bud in the scion, it has that much free point as compared to the entirely latex-covered area in shield budding.

The difference in percentage of success between patch budding and H-budding is so small that even in the former, the number of unions obtained may be considered negligible.

Different treatments given to scions and their influence on success in budding

No marked influence of either defoliation of the budwood two weeks before budding or cutting the branches and placing them in

sand a week before they were used for budding was shown (table 2). In the former, the average percentage of success was 2.77 ± 0.18 per cent, and in the latter, 0.17 ± 0.11 per cent. In the control lot (the bud sticks were used soon after they were cut from the tree), the successful union was 2.48 ± 0.11 per cent. The values obtained were so small that the statistical significance of their difference is not worth considering here.

Influence of stage of development of the buds

Throughout the experiment, dormant buds gave a higher percentage of success than buds showing a marked sign of start in growth (table 3). This may help to explain why defoliation and placing the bud sticks in sand previous to budding did not result in an increase in percentage of successful union. In both cases, the branches treated had a marked tendency for bud development.

This behavior is exactly the opposite of that of avocado (Gonzalez, 1925), mango (Wester, 1920), and lanzones (Lanusa)[5] in which scions with well formed buds about to open (natural or forced) gave the best result in budding and grafting.

Buds from medium-aged budwood proved better than buds secured from either young or old budwood (table 4). This result tends to point to the same conclusion that dormant buds in star apple are preferable to active buds for budding purposes. In old branches, dormant buds were available but appeared to have suffered physical injuries, being very much mummified and distinctly lacking in vigor. In other words, desirable buds seem to be those which are in a dormant stage but are well formed and healthy looking.

Influence of age of stock

Of the two lots compared, one and one-half year and three year old seedlings, the younger stocks proved better (table 5). This was also manifested when buds inserted at the top and middle portion gave a higher percentage of union than those at the basal region of the stock (table 6). On the basis of color of bark at the point of insertion, those inserted in green and light brown, corresponding to the top and medium portions of the stocks, proved better than those in dark brown or the basal part (table 7).

---

[5] LANUSA, A. E. 1937. Value of vegetatively grown lanzon. Agricultural-Industrial Monthly 5: 3 p., 2 fig.

Influence of different treatments given to the stocks before budding

The different treatments given to the stocks before budding, calculated to induce growth and perhaps increase the percentage of success, did not result in a very marked gain (table 8). All treated lots however, seem to be better than the control.

The shaded plants appeared greener and much more vigorous than the other lots. This lot gave the highest percentage of success, or 4.85 ± 0.20. Next came the balled plants with an average percentage of 3.30 ± 0.17. Plants in this group began sending out new shoots within eighteen days. The beginning of activation in growth as a consequence of balling and heavy pruning of the plants cannot be ascertained, but with the critical period for the buds estimated at 10 days, since they remain fresh that long when placed in sphagnum moss, there would have been sufficient time for the overlapping of the increased activity in the stock and freshness of the scion to start and effect union.

Statistically, the shaded and the balled groups are significantly better than the root pruned, top-pruned, and manured and irrigated lots, although in all the groups, the percentage of success obtained was still too low to make the method of propagation recommendable for the star apple.

Influence of different treatments on inducing the buds to grow

For a long time, some of the buds remained fresh but would not start to grow. Some of the branches immediately above the buds were ringed, severely pruned, and the stock was heavily manured and irrigated, but the buds could not be forced to develop. When the plants were balled, however, some of the buds started to grow in from seven to thirteen days; 37.50 per cent of the dormant buds were thus forced into growth (table 9 and fig. 1) when other methods failed. One out of six in top-pruned plants did not grow.

Heavy pruning of the roots alone did not force the buds to grow, and severe top pruning was only partly successful in inducing bud development. The number of buds considered, however, were so few that no definite conclusion can be drawn from the study at the present time.

Influence of season on success in budding

The highest percentage of success was obtained in August, 1939, and in January, 1940, values being 10.56 and 9.43 per cent, respec-

tively (table 3). At the beginning, a close correlation appeared to exist between percentage of success on the one hand and total rainfall and mean monthly temperature, or atmospheric humidity, on the other. This relationship, however, was not maintained to the end of the experiment except in the case of total rainfall, in which the close parallelism ran from July to December.

Fig. 1.—Growth of buds, forty-one days after balling the stock and thirty-four days after insertion of buds. Photograph by the Photographic Division, College of Agriculture.

SUMMARY AND CONCLUSION

1. Of the four methods of budding star apple tested, namely, the shield, the modified Forkert, the "H", and the patch, the modified Forkert method proved most effective.

2. Defoliating scion two weeks before budding or cutting the branches and placing them in sand a week before they were used for budding did not show any marked influence on success in budding.

3. Dormant buds were more effective than active ones in budding star apple. Perhaps this helps to explain why treatment to induce bud growth did not increase the percentage of union.

4. One and one-half year old stocks were better than three year old stocks. Well formed buds from medium aged budwood were most suitable for budding purposes.

5. In the three year old stocks, buds inserted at the top and middle portion yielded a higher percentage of success than those inserted on the basal region of the stock.

6. The color of the bark served as a good index of maturity of the stock and responded in the same order as the three year old stocks: green corresponding to top portions, light brown to the middle part, and dark brown to the basal region.

7. Treatments tending to increase activity of growth of the stock resulted in an increase in percentage of success in budding.

8. Although the buds remained green for three months, there was no apparent sign of growth, and some of those that were not given any treatment to force them into active development remained dormant until the end of the experiment.

9. Among the different methods of inducing the buds to grow, balling the budded plant was the most effective. Within thirteen days after balling, the bud showed marked signs of development, which could be readily seen.

10. The highest percentage of success was obtained in August, 1939, and in January, 1940. A close correlation seemed to exist between the increase in rainfall and success in budding, in direct ratio. More work should be done, however, before a very conclusive statement can be given on this point.

11. From the results obtained in the experiment, it does not seem practical to propagate the star apple by any of the methods herein tried, a much higher percentage of success having been obtained previously by using other methods of asexual propagation.

LITERATURE CITED

GONZALEZ, L. G. 1925. Some methods of asexual propagation of the avocado. The Philippine Agriculturist **13**: 433–440.

GONZALEZ, L. G., AND ARCON SONGMANI. 1940. A study of some asexual methods of propagation of the star apple. The Philippine Agriculturist **28**: 836–847.

MENDIOLA, N. B. 1931. Java selected Hevea clons successfully introduced. The Philippine Agriculturist **20**: 375–387.

MERCADO, T. 1934. Propagation of kapok by budding and grafting. The Philippine Agriculturist **23**: 131–139. *Fig. 1–4.*

OCHSE, J. J., AND R. C. BAKHUIZEN VAN DER BRINK. 1931. Fruits and fruit culture in the Dutch East Indies. 180 p. Batavia: G. Kolff and Company.

PACUMBABA, P. O. 1940. Comparative studies on the planting of budded and seedling kapok. The Philippine Agriculturist 28: 816–828.

WESTER, P. J. 1920. The mango. 2nd. rev. ed. Manila: Bureau of Printing.

WESTER. P. J. 1920. Plant propagation and fruit culture in the tropics. Philippine Bur. Agric. Bull. 32: 1–134.

TABLE 1

Response of the star apple to different methods of budding

METHODS	NO. OF BUDS INSERTED	NO. OF LIVING BUDS	PERCENTAGE OF LIVING BUDS	AVERAGE
Shield budding	30	0	0	
	17	0	0	
	29	0	0	
Modified Forkert	90	3	3.33	
	46	7	15.22	14.95 ± 4.70
	19	5	26.32	
H-budding	45	0	0	
	60	0	0	
	55	0	0	
Patch budding	432	6	1.13	
	501	7	1.38	1.27 ± 0.02
	363	5	1.37	

TABLE 2

The influence of different treatments on the scions to previous budding

METHODS	NO. OF BUDS INSERTED	NO. OF LIVING BUDS	PERCENTAGE OF LIVING BUDS	AVERAGE
Defoliated two weeks before budding	198	5	2.52	
	232	4	1.72	2.77 ± 0.184
	221	9	4.07	
Branches cut and planted in sand before budding	85	0	0	
	15	0	0	0.17 ± 0.114
	196	1	0.51	
Used for budding soon after being cut from the tree	201	5	2.43	
	248	3	1.21	2.48 ± 0.113
	214	6	2.80	

TABLE 3

The influence of stage of development of buds on percentage of success

MONTHS 1939-1940	ACTIVE			DORMANT		
	No. of buds inserted	No. of living buds	Percentage of living buds	No. of buds inserted	No. of living buds	Percentage of living buds
June	4	0	0	17	0	0.00
July	152	0	0	125	2	1.60
August	132	0	0	161	17	10.56
September	160	0	0	161	1	0.62
October	98	0	0	122	0	0.00
November	108	0	0	140	0	0.00
December	30	0	0	152	3	1.97
January	86	0	0	106	10	9.43

TABLE 4

The influence of young, medium, and old budwood on percentage of success

MONTHS 1939-1940	BUDS FROM YOUNG BUDWOOD			BUDS FROM MEDIUM AGED BUDWOOD			BUDS FROM OLD BUDWOOD		
	No. of buds inserted	No. of buds living	Percentage success	No. of buds inserted	No. of buds living	Percentage success	No. of buds inserted	No. of buds living	Percentage success
June	15	0	0.00	23	0	0.00	14	0	0.00
July	126	0	0.00	109	4	3.67	50	0	0.00
August	51	0	0.00	125	13	10.40	23	0	0.00
September	16	0	0.00	307	2	0.65	46	0	0.00
October	36	0	0.00	94	1	1.06	38	0	0.00
November	40	0	0.00	190	0	0.00	67	0	0.00
December	24	0	0.00	195	2	1.03	32	1	3.13
January	26	0	0.00	164	10	6.10	0	0	0.00
Average	—	—	—	—	—	2.85	—	—	0.45

TABLE 5

The influence of age of stock on success in budding

AGE OF STOCK	NO. OF BUDS INSERTED	NO. OF LIVING BUDS	PERCENTAGE OF LIVING BUDS	AVERAGE
1½ years	46	1	2.17	3.33 ± 0.39
	51	2	3.92	
	51	2	3.92	
3 years	496	9	1.82	1.93 ± 0.67
	543	10	1.84	
	423	9	2.13	

TABLE 6

The influence of inserting the buds at different parts of the stock

MONTHS 1939-1940	TOP PORTION			MIDDLE PORTION			BASAL PORTION		
	No. of buds inserted	No. of living buds	Percentage of living buds	No. of buds inserted	No. of living buds	Percentage of living buds	No. of buds inserted	No. of living buds	Percentage of living buds
June							21	0	0
July							277	2	0.722
August	51	5	9.80	9	4	44.44	233	8	3.43
September ..	55	0	0	57	0	0	209	1	0.478
October	2	0	0	42	0	0	176	0	0
November ...	32	0	0	34	0	0	182	0	0
December ...				12	1	3.33	170	1	0.588
January	9	4	44.44	25	3	12.00	158	3	1.89
Average			10.88			10.59			1.015

TABLE 7

Color of the bark at the point of insertion as an indication of stage of maturity and influence thereof on percentage of success

COLOR OF BARK	NO. OF STOCKS USED	NO. OF BUDS INSERTED	NO. OF LIVING BUDS	PERCENTAGE OF LIVING BUDS	AVERAGE
Green	42	42	3	7.14	6.60 ± 0.20
	30	60	4	6.16	
	22	46	3	6.52	
Light brown	25	42	3	7.14	6.32 ± 0.39
	20	30	2	6.66	
	20	58	3	5.17	
Dark brown	205	445	5	1.12	1.19 ± 0.13
	220	567	5	0.88	
	241	320	5	1.56	

TABLE 8

The influence of different treatments given to the stock before budding

TREATMENTS	NO. OF STOCKS USED	NO. OF BUDS INSERTED	NO. OF LIVING BUDS	PERCENTAGE OF LIVING BUDS	AVERAGE PERCENTAGE OF SUCCESS
Control	53	132	0	0	0
	35	141	0	0	
	34	146	0	0	
Root-pruned	6	12	0	0	1.73 ± 1.39
	6	11	0	0	
	7	19	1	5.25	
Balled	12	34	0	0	3.30 ± 0.17
	12	36	1	2.77	
	12	28	2	7.14	
Top-pruned	80	160	2	1.25	1.22 ± 0.03
	88	166	2	1.20	
	84	162	2	1.23	
Manured and irrigated	48	125	0	0	0.46 ± 0.16
	51	146	1	0.68	
	35	141	1	0.70	
Shaded	25	38	2	5.26	4.85 ± 0.20
	45	62	3	4.83	
	62	67	3	4.47	

TABLE 9

The influence of different treatments on the buds to induce growth

TREATMENTS	NO. OF DORMANT BUDS USED	NO. OF BUDS THAT GREW	PERCENTAGE OF SUCCESS
Control	15	0	0
Top pruning	6	1	16.66
Balling	16	6	37.50
Root pruning	1	0	0
Manured and irrigated	2	0	0
Shading	8	0	0
Ringing	18	0	0

TABLE 10

Weather conditions at the College Campus from June, 1939, to January, 1940

MONTHS	TOTAL RAINFALL	TEMPERATURE		ATMOSPHERIC HUMIDITY	DATE OF OCCURRENCE OF STRONG WINDS OF MORE THAN 100 MILES PER HOUR
		Means of daily maximum and minimum	Mean based on 3 readings daily		
	mm.	°C.	°C.	*per cent*	
June	210.9	28.1	27.08	72.94	June 24, 1939
July	170.8	27.7	27.17	67.78	July 1, 11, 12, 20, 21, 22, 27, 28, 29, 30, 31
August	279.5	27.8	27.63	79.67	Aug. 1, 1939
September	190.3	27.5	27.43	71.42	Sept.—none
October	161.0	27.2	27.02	73.33	Oct. 8, 1939
November	348.2	26.3	26.37	74.90	Nov. 13, 1939
December	598.0	24.0	23.82	73.32	Dec. 1, 3, 4, 13, 18, and 30, 1939
January	187.0	24.8	24.45	69.31	Jan. 4, 19, 26, 27, and 30, 1940

DETERMINATION OF FERTILIZER REQUIREMENTS OF CORN PLANT WHEN GROWN IN LIPA CLAY LOAM[1]

JOSÉ MADRIGAL, JR.

Vibar (1911) reported that the application of 17.5 kgm. of kainit gave an increase of 85.04 kgm. of husked corn per hectare. He also reported that 10 kgm. tankage with 8.75 kgm. basic slag increased the yield by 297.66 kgm. per hectare. Tankage applied at the rate of 10 kgm. with 17.5 kgm. of kainit increased the yield by 281.04 kgm. to the hectare, whereas 8.75 kgm. basic slag with 17.5 kgm. of kainit increased the yield by 168.84 kgm. per hectare. The combination of the three single fertilizers showed the greatest effect; an increase of 475.86 kgm. of husked corn per hectare was obtained.

Montellano (1916) reported that superphosphate, when used at moderate rates of 142.5 kgm. to 285.0 kgm. per hectare of each gave the greatest increase in yield of marketable ears; the next highest increase in yield was obtained from the combination of superphosphate and nitrate of soda at the rate of 760 kgm. per hectare. The largest yield of stover was obtained from the mixture of 227.5 kgm. sulfate of ammonia, 795.8 kgm. single superphosphate, and 340.8 kgm. muriate of potash per hectare.

On the effects upon the yield of corn of the application of varying amounts of ammonium sulfate, Aragon and Esguerra (1935) found that the control plots gave the lowest average yield of 20.58 cavans of shelled corn per hectare; the 50 kgm. treatment, 22.92 cavans; the 100 kgm. treatment, 30.20 cavans; the 150 kgm. treatment, 30.23 cavans; and the 200 kgm., 31.56 cavans, the highest yield obtained in the lot.

Objects of this study

This study was undertaken with the object of determining by pot cultures the fertilizer or fertilizer mixtures conducive to good growth and high yields of corn plants when grown in Lipa clay loam.

---

[1] Experiment Station contribution No. 1416. Prepared in the Department of Agricultural Botany, under the direction of Professor Rafael B. Espino.

Time and place of this study

The culture part of this study was conducted in the experimental yard of the Department of Agricultural Botany, from December, 1938, to February, 1940.

MATERIALS AND METHODS

Plants

The corn plants used were of the variety Calauan yellow flint. The seeds were obtained from the Department of Agronomy and were soaked in water for twenty-four hours before planting. Four seeds were planted in each pot. When the seedlings were about two weeks old, they were thinned and only two healthy plants were left in a pot.

Soil

Lipa clay loam, taken from a lot near the U. P. Rural High School Reservation, was pulverized, sieved, mixed thoroughly, and allowed to dry under a shed. Nineteen kilograms of air-dried soil were placed in each kerosene tin. Samples of the soil were analyzed in the Department of Agricultural Chemistry for available plant nutrients and were found to contain 0.00264 per cent of N, 0.00279 per cent of P_2O_5, and 0.02228 per cent of K_2O.

Culture media

Six sets of culture media were employed. Each set consisted of six or seven cultures, and each culture was tried in quadruplicate. Four of these sets of cultures were each run twice, so that a total of 256 pot cultures was tested.

Ammonium sulfate. Six types of cultures were supplied with ammonium sulfate in the following amounts: 1.5 grams (0.31 gram N), 3.0 grams (0.62 gram N), 4.5 grams (0.93), 6.0 grams (1.24 grams N), 7.5 grams (1.55 grams N), and the control without fertilizer.

Sodium nitrate. Six cultures were supplied with sodium nitrate in the following quantities: 1.93 grams (0.31 gram N), 3.87 grams (0.62 gram N), 5.81 grams (0.93 gram N), 7.75 grams (1.24 gram N), 9.68 grams (1.55 grams N), and the control none.

Ammonium sulfate and superphosphate. To five of six cultures which contained the optimum amount of ammonium sulfate, or 7.5 grams (1.55 grams N), superphosphates in the following quantities

were added: 1.5 grams, 3.0 grams, 4.5 grams, 6.0 grams, and 7.5 grams.

Sodium nitrate and superphosphate. To five of six of the cultures which contained the optimum amount of sodium nitrate, or 9.68 grams (1.55 grams N), superphosphate of the following quantities were added: 1.5 grams, 3.0 grams, 4.5 grams, 6.0 grams, and 7.5 grams.

Ammonium sulfate, superphosphate, and potassium sulfate. In addition to the unfertilized control, four of the five cultures which contained the optimum amounts of ammonium sulfate (7.5 grams) and superphosphates (7.5 grams) were given the following quantities of potassium sulfate: 1.5 grams, 3.0 grams, 4.5 grams, and 6.0 grams.

Sodium nitrate, superphosphate, and potassium sulfate. In addition to the unfertilized control, four of the five cultures that contained the optimum amount of sodium nitrate (9.68 grams) and the superphosphate (6.0 grams) were given the following quantities of potassium sulfate: 0.5 grams, 3.0 grams, 4.5 grams, and 6.0 grams.

Time of application

The plants were fertilized two weeks after planting, and by this time they had attained a height of from five to six centimeters above the ground. A furrow was made around the plants, the fertilizers applied uniformly in it, and afterwards covered.

EXPERIMENTS AND RESULTS

The cultures

The ammonium sulfate set was started on December 30, 1938; and on March 8, 1939, the plants were harvested.

The sodium nitrate set was started also on December 30, 1938, and harvested on March 8, 1939.

The ammonium sulfate and superphosphate set was started on May 3, 1939; and at maturity, the cultures were harvested. This set of cultures was repeated on September 8, 1939, and at maturity the plants were harvested.

The sodium nitrate and superphosphate set was started also on May 3, 1939; and at the time of maturity, the plants were harvested. A similar set of cultures was started on September 8, 1939; and at the time of maturity of the ears, the cultures were harvested.

The cultures referred to as the ammonium sulfate, superphosphate, and potassium sulfate set were started on September 8, 1939;

LIBRARY

and on November 30, 1939, when the ears were ripe enough, the cultures were harvested. A similar set of cultures was started on December 8, 1939, and harvested on February 15, 1940.

The cultures herein designated as the sodium nitrate, superphosphate, and potassium sulfate set were started also on September 8, 1939; and on November 30, 1939, they were harvested. This set was repeated on December 8, 1939; and on February 15, 1940, the cultures were harvested.

Care of cultures

The cultures were exposed to the sun and rain. They were watered and weeded as often as necessary. From two weeks after germination, the cultures were frequently cultivated. Care was taken to protect the plants from diseases, pests, and bad weather.

Criteria of results

The criteria of results used in this study are:

Height of plants. The plants in each culture were measured weekly from a base mark near the surface of the soil in pots to the last visible ligule. The data on height of the plants in each culture were taken on the tenth week of growth when the plants were 65 days old and still apparently healthy.

Weight of sun-dried tops. The tops from each culture were cut close to the ground, wrapped in paper, and dried in the sun. When sufficiently dried, the different cultures were weighed separately, and the data obtained were averaged.

Weight of sun-dried ears. The ears from each culture were gathered and exposed to the sun to dry. When dry enough, the ears from each culture were weighed.

Weekly growth increments

For a general idea of the weekly growth characteristics of the corn plants when supplied with different fertilizers or when treated with a fertilizer in varying amounts, the growth of the plants in the different sets of cultures were measured weekly for seven weeks. The data obtained are briefly summarized in table 1.

DISCUSSION OF RESULTS

Small ears produced

Observations have shown that all the plants grown on Lipa clay loam alone were stunted and either produced no ears or very small

or undeveloped ones. The plants in the fertilized cultures, however, were apparently very vigorous and tall, but the ears were abnormally small when compared with the size of those ordinarily produced by this corn variety grown on fertile soil.

Rates of growth of corn plants

With a few exceptions, the weekly growth increments of the corn plants studied kept on progressively increasing until the maximum rate was reached. Thence, the rates of growth began to diminish until the plants were harvested. The two weeks of fastest growth of the plants appeared to differ in the different sets of cultures tried and apparently were materially influenced by the season of planting (table 1). These two weeks of fastest growth were during the third week as the earliest and the seventh as the latest. Most of the plants reached their fastest weekly growth increments during the third, fourth, or fifth week. Usually after the fifth week, the plants had materially declined in growth and were then approaching maturity.

In general the control, or unfertilized plants, grew the slowest (table 1). In one way this was expected. With a few exceptions, the weekly growth increments increased with either of the two nitrogenous fertilizers employed. In some culture sets, however, the highest application of these fertilizers was accompanied by a slightly reduced rate of growth during certain weeks.

The range of weekly growth increments observed was from 0.2 cm. in the control culture to as much as 74.62 cm. in certain cultures supplied with a combination of ammonium sulfate and superphosphate (table 1). Not infrequently, corn plants recorded growth increments of more than 60 cm. in a week. The fertilized corn plants in the different culture sets attained most of their growth increments usually during a period of two weeks, very rarely more (table 1).

Comparative effects of varying amounts of ammonium sulfate

Casual observations have shown that the plants in cultures I to V, which were supplied with varying amounts of ammonium sulfate, had a better growth than those in culture VI, the unfertilizer one. The varying rates of application of the fertilizer resulted in the different stands of the plants. In order to facilitate the choosing of the most promising culture, the two highest values under each criterion were arbitrarily selected and indicated by H's. The results show that most of the H's fall in cultures IV and V, with the latter some

what better than culture IV. Culture V, which received 7.5 grams of ammonium sulfate per pot, may, therefore, be considered the best in the lot.

Comparative fertilizing effects of varying amounts of sodium nitrate

When the stands of the plants treated with varying amounts of Arcadia sodium nitrate were compared with one another and with the unfertilized culture, it was seen that the NO_3-fertilized plants were very much superior to those in culture VI, the unfertilized one. Cultures Ia to Va, which received increasing amounts of sodium nitrate, produced plants of variable heights; the plants in cultures Ia, IIa, and IIIa appeared to be the shortest, and those in IVa and Va, the tallest.

Cultures IIa and IIIa appear to have the tallest plants. It thus seems advisable that in this set of cultures, the choice of the two most promising cultures might be based on the dry weight of tops. If this is the case, then cultures IVa and Va may be considered the best, with IVa somewhat better than Va. Through an oversight, however, culture Va, which received 9.68 grams of Arcadia sodium nitrate, was selected for further experiments.

Amounts of superphosphate to add to ammonium sulfate to improve further the growth and yield of corn

The plants in this set of cultures were nearly equal in height. With the exception of the control, or unfertilized culture, the data on heights of plants were about the same. Moreover, in these two sets of culture the data on dry weight of tops did not follow any definite trend; that is, they were so variable that they apparently were not influenced one way or another by the amount of superphosphate employed.

On yield of ears, however, the amount of superphosphate used apparently had a marked influence. For this reason, it seemed advisable to use the data on yield of ears as the criterion for the selection of the two best cultures in the two sets. Evidently, this was done, and cultures V and VI were found the best, with culture VI somewhat better than culture V. Culture VI, which received 7.5 grams of ammonium sulfate and 7.5 grams of superphosphate, was, therefore, selected for use for further experiments.

In order to find out whether or not there was justification in adding superphosphate with ammonium sulfate to Lipa clay loam for

corn, statistical comparisons of certain data obtained from some of the cultures were made. The results showed that in terms of the mean dry weight of top, no significant differences were found between the cultures that received both ammonium sulfate and superphosphate and the culture supplied only with ammonium sulfate. In the mean dry weight of ears, however, statistically significant differences were obtained. In the production of ears of corn, therefore, superphosphate should be added with ammonium sulfate to Lipa clay loam.

Aside from culture I, which received only ammonium sulfate, two other cultures were selected for statistical comparison. One of these was high in yield of corn ear. The statistical data obtained showed that the yield obtained from the culture applied with ammonium sulfate alone was not statistically different from those which received ammonium sulfate and superphosphate. Between cultures VI and I, however, a significant difference in terms of mean dry weight of ears occurred in favor of VI, which received both ammonium sulfate and superphosphate.

Amount of superphosphate to add to sodium nitrate to improve further the growth and yield of corn

In the sodium nitrate and superphosphate sets, the two highest values under each criterion were arbitrarily selected and indicated by H's. It now appears that under height of plants and dry weight of tops, the distribution of the H's, or the two highest actual values, was not materially influenced by any particular amount of superphosphate employed. In dry weight of ears, however, culture Va was the highest in the two sets tested. This culture, which contained 9.68 grams of sodium nitrate and 6 grams of superphosphate, was selected for use in later experiments.

Two of the most promising cultures were selected and compared with the control culture. The statistical differences obtained showed that the mean dry weights of ears of corn produced by plants grown on Lipa clay loam and supplied with sodium nitrate and superphosphate were not statistically different from the yield obtained by the culture supplied only with nitrate of soda. Even in terms of the mean dry weight of tops, culture IVa was not significantly different from culture Ia. Between cultures Va and Ia, and cultures IVa and Va, however, statistically significant differences occurred in terms of the mean dry weight of tops.

Again, two of the most promising cultures were arbitrarily selected and compared with the control. The statistical data obtained showed that superphosphate should be added to sodium nitrate. The difference in yield obtained by the cultures supplied with a combination of the two fertilizers was statistically better than that obtained in the culture supplied with sodium nitrate only.

Amount of potassium sulfate to add to ammonium sulfate and superphosphate to improve further the growth and yield of corn

Observations have shown that all the fertilized plants were tall and apparently equally well-developed. The control, or unfertilized plants, however, remained markedly stunted and decidedly chlorotic. All the fertilizer mixtures, consisting of ammonium sulfate, superphosphate, and potassium sulfate, were very effective in promoting the vegetative development of the corn plants.

The two highest yield values of tops were from cultures II and III. The two highest data on dry weight of corn ear were from cultures III and IV in one set of cultures and IV and V in the other set. In the production of ears, culture IV was selected from the two sets and might, therefore, be considered as substantially the highest yielder.

A better appraisal, however, of the comparative merits of the different cultures in a set is by statistical method. In view of this, the cultures in each set were statistically compared with one another in terms of mean dry or fresh weight of ears. Incidentally, of the three criteria of results employed in this study, this one is undoubtedly the best. The statistical comparisons made are recorded in table 2.

Table 2 also showed that culture VI, which contained only Lipa clay loam, was not compared with any of the fertilized cultures. The reason was obvious; the unfertilized culture was decidedly inferior to any of the fertilized ones.

From the comparisons in table 2, the following points or generalizations are worthy of note:

(*a*) The difference between culture VII, which received only ammonium sulfate, and any of the other fertilized cultures was statistically insignificant. Data were taken from the second set of cultures only.

(*b*) Culture I, which received both ammonium sulfate and superphosphate but no potassium sulfate, produced fewer ears of corn

than any of the cultures that received a mixture of the complete fertilizers. The differences, however, were statistically insignificant.

(*c*) The statistically significant differences in the first set of cultures were the following: III better than II, II better than V, and III better than V. These cultures may be considered probably as high yielders, with culture III as the best.

In the other set, the statistically significant differences were noted as follows: I better than II or III, IV better than II or III, V better than II or III. Therefore, cultures II and III might be eliminated from this group, leaving cultures I, IV, and V as the most promising, with IV the best.

(*d*) From the foregoing analyses, it may be safe to conclude that for corn grown on Lipa clay loam in pots, the best complete fertilizer is one consisting of 7.5 grams each of ammonium sulfate and superphosphate, and 3 to 6 grams of sulfate of potash per pot of two corn plants.

Amount of potassium sulfate to add to sodium nitrate and superphosphate to improve further the growth and yield of corn plant

The stands of the fertilized plants were excellent—tall and green. The unfertilized plants were dwarfed and decidedly chlorotic. The experimental data obtained from these plants are statistically compared in table 3.

Most of the comparisons made in table 3 showed statistically insignificant differences. Significant differences, however, were obtained in four comparisons in the first set of cultures and two comparisons in the second set. In the first set, culture II was better than I or V, III better than V, and IV better than I. The most promising cultures in the first set were, therefore, II, III, and IV. In the second set of cultures, culture I was better than either V or VII. But culture I had been surpassed by other cultures in the first set, and although it was a fairly good culture in either set, it might probably be well to eliminate it altogether. Therefore, the most promising culture medium for corn grown on Lipa clay loam is one consisting of 9.68 grams of Arcadia sodium nitrate, 6 grams of superphosphate, and 1.5 to 4.5 grams of potassium sulfate per pot.

The N-P_2O_5-K_2O contents

Chemical analyses of samples of the Lipa clay loam employed in this study showed that the soil contained 0.00264 per cent of available N, 0.00279 per cent of available P_2O_5, and 0.02228 per cent of

available K_2O. The soil in each pot weighing 19 kgm., or 19,000 grams, must have had 0.5016 gram of N, 0.5319 gram of P_2O_5, and 4.2332 grams of K_2O, all in available forms.

If to these figures were to be added the amount of N, P_2O_5, and K_2O, which the best complete fertilizer (culture IV in table 4) for corn had added to the soil, the culture medium would have contained 2.0466 grams of N, 1.8819 grams of P_2O_5, and 6.3932 grams of K_2O, also all in available forms.

The original available N, P_2O_5, and K_2O contents of the soil in one hectare 30 centimeters in depth (the depth of the soil in the pots, and almost equal to one foot) were computed and found to be 94.8 kgm. of N, 100.2 kgm. of P_2O_5, and 800.2 kgm. of K_2O. Converting these figures into Baule units per hectare, we have 0.4 Baule [2] unit of N, 2 Baule units of P_2O_5, and 8.7 Baule units of K_2O. It was thus seen that the original fertility of the soil was very low in N, rather low in P_2O_5, and had enough K_2O to produce a good crop.

If the yield-producing potency equation, $\log (100\text{-}y) = 2\text{-}(0.301.x)$ is employed, the "fertility index" of the Lipa clay loam used may be computed (Willcox, 1930). The computations were done, and the results showed that the yield-producing potency of 0.4 Baule unit of N was about 25 per cent; that of 2 Baule units of P_2O_5, 75 per cent; and that of 8.7 Baule units of K_2O, 99.8 per cent. If the percentage yield-producing values found are multiplied together, the results will be:

$0.25 \times 0.75 \times 0.998 = 0.18725$, or 18.73 per cent. These figures represent the fertility index of the Lipa clay soil and show that it was capable of producing only 18.73 per cent of the maximum crop.

If the available N, P_2O_5, and K_2O contents of the most promising culture pot (culture IV) were to be transformed into a one-hectare basis, then the total amount of available plant nutrient constituents (those originally present in the soil plus those from the fertilizers) would be 386.8 kgm. of N, 353.8 kgm. of P_2O_5, and 1208.5 kgm. of K_2O. These fertilizing ingredients were equivalent to 1.5 Baule units of N, 7 Baule units of P_2O_5, and 13.2 Baule units of K_2O. Their yield-producing potencies were found, by computation, to be as follaws: the 1.5 Baule units of N were equivalent to 64.5 per cent; the 7 Baule units of P_2O_5, to 99.2 per cent; and the 13.2 Baule units, to

[2] By a Baule unit is meant the quantity of any of these fertilizing ingredients capable of producing 50 per cent of the maximum yield of any crop, provided all the other conditions and growth factors are at their best or are amply supplied.

more than 100 per cent. This amount of potash was excessive even from the standpoint of agrobiology, or the welfare of the plant.

Multiplying together these yield-producing potencies, we have: $0.645 \times 0.992 \times 1.00 = 0.63984$, or 64 per cent.

Therefore, the fertility index of the best culture medium was found to be 64 per cent of the maximum possible yield. Following the application of the fertilizers, the fertility index of the medium was raised from 18.73 to 64 per cent.

SUMMARY AND CONCLUSIONS

1. Although apparently tall, healthy, and vigorous, the fertilized corn plants produced rather small ears.

2. The weekly growth increments of corn observed ranged from 0.2 cm. in the control culture to as much as 74.62 cm. in certain cultures supplied with a combination of ammonium sulfate and superphosphate.

3. The two weeks of fastest growth were during the third week as the earliest and the seventh as the latest. Most of the corn plants reached their fastest weekly growth increment during the third, fourth, or fifth week.

4. Varying rates of application of ammonium sulfate resulted in a variation of stand of the corn plants. The addition of 7.5 grams of ammonium sulfate was found to be the best.

5. In the production of ears of corn, a mixture of 7.5 grams of ammonium sulfate and an equal amount of superphosphate gave good results when added to Lipa clay loam.

6. The addition of 9.68 grams Arcadia sodium nitrate to Lipa clay loam and 6 grams superphosphate produced a high yield of corn ears.

7. The best complete fertilizer for corn contained 7.5 grams each of ammonium sulfate and superphosphate and 3 to 6 grams of sulfate of potash per pot.

8. Another promising fertilizer mixture for corn contained 9.68 grams of Arcadia sodium nitrate, 6 grams of superphosphate, and 1.5 to 4.5 grams of potassium sulfate per pot.

9. With the application of the best fertilizer mixture found, the fertility index of the Lipa clay loam was raised from 18.73 to 64 per cent of the maximum possible yield.

LITERATURE CITED

ARAGON, V. B., AND J. P. ESGUERRA. 1933. A report on the immediate and residual effects of ammonium sulfate fertilizer. The Philippine Agriculturist 24: 219–228.

MONTELLANO, P. L. 1916. A study of the effects of commercial fertilizers on corn. The Philippine Agriculturist and Forester 4: 217–230.

VIBAR, T. N. 1911. The influence of K.P.N. on the growth and production of corn. The Philippine Agriculturist and Forester 1: 175–187.

WILLCOX, OSWIN W. 1930. Principles of agrobiology or the laws of plant growth in relation to crop production. 96 p. New York: Palmer Publishing Corporation.

TABLE 1

Summary of the weekly growth increments

CULTURE NO.	FERTILIZER INGREDIENTS	RANGE OF GROWTH INCREMENTS	WEEKS OF FASTEST GROWTH	FIRST WEEK MEASUREMENTS
1	NH_4	0.20 — 29.40	6th and 7th	
2	NO_3	0.47 — 26.80	6th and 7th	Jan. 17-24/39
3	$NH_4 + PO_4$	3.78 — 74.62	4th and 5th	
4	$NO_3 + PO_4$	4.76 — 69.72	4th and 5th	May 18-25/39[a]
5	$NH_4 + PO_4$	9.83 — 58.75	3rd to 5th	
6	$NO_3 + PO_4$	7.46 — 67.18	3rd to 5th	Sept. 22-29/39
7	$NH_4 + PO_4 + K$	5.45 — 62.96	3rd to 5th	
8	$NO_3 + PO_4 + K$	4.71 — 63.81	3rd to 5th	Sept. 22-29/39
9	$NH_4 + PO_4 + K$	0.98 — 48.75	5th and 6th	
10	$NO_3 + PO_4 + K$	0.63 — 41.50	5th and 6th	Dec. 22-29/39

[a] The best planting time for corn in Los Baños.

TABLE 2

Statistical comparisons of the yields of corn ears from cultures supplied with ammonium sulfate, superphosphate, and potassium sulfate

CULTURES COMPARED	MEAN SUN DRY WEIGHT OF EARS	DIFFERENCE	REMARKS
I-II	116.0 ∓ 9.92 — 117.0 ∓ 3.89	— 1.0 ∓ 10.61	Insignificant
I-III	116.0 ∓ 9.92 — 142.0 ∓ 11.27	— 26.0 ∓ 14.98	Insignificant
I-IV	116.0 ∓ 9.92 — 143.0 ∓ 18.11	— 27.0 ∓ 20.62	Insignificant
I-V	116.0 ∓ 9.92 — 84.7 ∓ 15.18	— 31.3 ∓ 18.11	Insignificant
II-III	117.0 ∓ 3.89 — 142.0 ∓ 11.7	— 25.0 ∓ 11.92	Significant
II-IV	117.0 ∓ 3.89 — 143.0 ∓ 18.11	— 26.0 ∓ 18.52	Insignificant
II-V	117.0 ∓ 3.89 — 84.7 ∓ 15.18	32.0 ∓ 15.63	Significant
III-IV	142.0 ∓ 11.27 — 143.0 ∓ 18.11	— 1.0 ∓ 21.33	Insignificant
III-V	142.0 ∓ 11.27 — 84.7 ∓ 15.18	57.3 ∓ 18.89	Significant
IV-V	143.0 ∓ 18.11 — 84.7 ∓ 15.18	58.3 ∓ 23.61	Significant
	MEAN FRESH WEIGHT OF EARS		
I-II	224.2 ∓ 31.87 — 159.2 ∓ 3.50	65.0 ∓ 32.49	Significant
I-III	224.2 ∓ 31.87 — 148.7 ∓ 13.22	75.5 ∓ 34.55	Significant
I-IV	224.2 ∓ 31.87 — 274.2 ∓ 44.38	— 50.0 ∓ 54.70	Insignificant
I-V	224.2 ∓ 31.87 — 254.7 ∓ 17.06	— 30.5 ∓ 36.09	Insignificant
I-VII	224.2 ∓ 31.87 — 180.0 ∓ 40.35	44.8 ∓ 51.50	Insignificant
II-III	159.2 ∓ 3.50 — 148.7 ∓ 13.22	10.3 ∓ 13.67	Insignificant
II-IV	159.2 ∓ 3.50 — 274.2 ∓ 44.38	—115.0 ∓ 44.51	Significant
II-V	159.2 ∓ 3.50 — 254.7 ∓ 17.06	— 95.5 ∓ 17.44	Significant
II-VII	159.2 ∓ 3.50 — 180.0 ∓ 40.35	— 20.8 ∓ 40.65	Insignificant
III-IV	148.7 ∓ 13.22 — 274.2 ∓ 44.38	—125.5 ∓ 46.30	Significant
III-V	148.7 ∓ 13.22 — 154.7 ∓ 17.06	—106.0 ∓ 21.61	Significant
III-VII	148.7 ∓ 13.22 — 180.0 ∓ 40.35	— 31.3 ∓ 42.50	Insignificant
IV-V	274.2 ∓ 44.38 — 254.7 ∓ 17.06	19.5 ∓ 47.51	Insignificant
IV-VII	274.2 ∓ 44.38 — 180.0 ∓ 40.35	94.2 ∓ 59.98	Insignificant
V-VII	254.7 ∓ 17.06 — 180.0 ∓ 40.35	74.7 ∓ 43.85	Insignificant

TABLE 3

Statistical comparisons of the yields of corn ears from cultures supplied with sodium nitrate, superphosphate, and potassium sulphate

CULTURES COMPARED	MEAN SUN DRY WEIGHT OF EARS	DIFFERENCE	REMARKS
Ia—IIa	92.0 ∓ 8.84 — 125.6 ∓ 11.07	−33.6 ∓ 14.18	Significant
Ia—IIIa	92.0 ∓ 8.84 — 116.0 ∓ 11.53	−24.0 ∓ 14.51	Insignificant
Ia—IVa	92.0 ∓ 8.84 — 142.2 ∓ 12.62	−50.2 ∓ 15.82	Significant
Ia—Va	92.0 ∓ 8.84 — 82.0 ∓ 12.18	10.0 ∓ 15.02	Insignificant
IIa—IIIa	125.6 ∓ 11.07 — 116.0 ∓ 11.53	9.6 ∓ 15.98	Insignificant
IIa—IVa	125.6 ∓ 11.07 — 142.2 ∓ 12.62	−16.6 ∓ 16.79	Insignificant
IIa—Va	125.6 ∓ 11.07 — 82.0 ∓ 12.18	43.6 ∓ 16.42	Significant
IIIa—IVa	116.0 ∓ 11.53 — 142.2 ∓ 12.62	−26.2 ∓ 17.09	Insignificant
IIIa—Va	116.0 ∓ 11.53 — 82.0 ∓ 12.18	34.0 ∓ 16.78	Significant
IVa—Va	142.2 ∓ 12.62 — 82.0 ∓ 12.18	60.2 ∓ 17.51	Significant
	MEAN FRESH WEIGHT OF EARS		
Ia—IIa	163.0 ∓ 32.90 — 86.0 ∓ 39.51	77.0 ∓ 51.49	Insignificant
Ia—IIIa	163.0 ∓ 32.90 — 100.5 ∓ 19.41	62.5 ∓ 38.31	Insignificant
Ia—IVa	163.0 ∓ 32.90 — 100.1 ∓ 22.19	62.9 ∓ 39.95	Insignificant
Ia—Va	163.0 ∓ 32.90 — 89.3 ∓ 16.56	73.7 ∓ 36.90	Significant
Ia—VIIa	163.0 ∓ 32.90 — 67.0 ∓ 11.18	96.0 ∓ 34.74	Significant
IIa—IIIa	86.0 ∓ 39.51 — 100.5 ∓ 19.41	−14.5 ∓ 44.20	Insignificant
IIa—IVa	86.0 ∓ 39.51 — 100.1 ∓ 22.19	−14.1 ∓ 45.46	Insignificant
IIa—Va	86.0 ∓ 39.51 — 89.3 ∓ 16.56	− 3.3 ∓ 42.85	Insignificant
IIa—VIIa	86.0 ∓ 39.51 — 67.3 ∓ 11.18	18.7 ∓ 41.12	Insignificant
IIIa—IVa	100.5 ∓ 19.41 — 100.1 ∓ 22.19	0.4 ∓ 29.51	Insignificant
IIIa—Va	100.5 ∓ 19.41 — 89.3 ∓ 16.56	11.2 ∓ 25.60	Insignificant
IIIa—VIIa	100.5 ∓ 19.41 — 67.3 ∓ 11.18	33.2 ∓ 22.42	Insignificant
IVa—Va	101.1 ∓ 22.19 — 89.3 ∓ 16.56	10.8 ∓ 27.75	Insignificant
IVa—VIIa	100.1 ∓ 22.19 — 67.3 ∓ 11.18	32.8 ∓ 24.86	Insignificant
Va—VIIa	89.3 ∓ 16.56 — 67.3 ∓ 11.18	22.0 ∓ 19.98	Significant

BAMBOO CATHETERS IN THE TREATMENT OF UDDER TROUBLES[1]

MIGUEL MANRESA AND F. B. SARAO
Of the Department of Animal Husbandry

WITH ONE TEXT FIGURE

With the increase in the number as well as in the quality of dairy animals in the College of Agriculture, the incidence of udder troubles among milch cows has also mounted. Many of these are serious cases of lacerated wounds often involving the teat canals. After the wounds have been sutured, the inflammation renders the affected part of the udder so tender that milk has to be drawn out by means of milk tubes or catheters. The problem has been to find milk tubes which could be left hanging in the teat canals to let out the milk as it gets into the cavity of the teat, thus preventing distension of the udder and rupture of the sutures. Milk tubes made out of metal are slippery, and even those which have been made to be self-retaining cannot be held in the teat canal for a long time because they are relatively heavy. Milk tubes of soft rubber may be held longer than metal tubes in the teat canal if secured to the udder by ligatures, but because the teat canals of most of our dairy cows are small and the holes of the rubber tubes must be relatively small owing to the flexibility of the material, it was found impossible to prevent accumulation of the milk in the udder. What we needed was a milk tube which could be made of material stiff enough to resist pressure in the teat canal with capacity for maximum outlet, and light enough not to fall out but remain in place until removed. After much search and experimentation, we have found this material in *Bambusa multiplex* (Lour.) Raeusch., a dwarf ornamental bamboo better known as "caña de China."

SELECTION OF MATERIAL

As nearly mature stalks as possible of *Bambusa multiplex* are cut from standing plants. The nodes are removed leaving only the internodes which are allowed to dry in the shade for a few days under

[1] Experiment station contribution No. 1417.

ordinary room temperature. The pieces having holes varying in diameter from 1.5 to 3.5 millimeters are sorted out. These diameters can be determined accurately with the aid of a vernier caliper. For convenience, pieces of multiplex bamboo are divided on the basis of the diameters of their holes into four classes as follows: (*a*) from 1.5 to 2.0 mm., (*b*) from 2.0 to 2.5 mm., (*c*) from 2.5 to 3.0 mm., and (*d*) from 3.0 to 3.5 mm. The tubes in each class are now cut into varying lengths from 4.5 to 9.5 centimeters, each length increasing by one centimeter, thus giving six tubes of different lengths in each class. These constitute the raw material from which milk catheters can be rapidly prepared. Ordinary cases of udder trouble require the use of sizes of holes 1.5 to 2.0 mm. and 2.0 to 2.5 mm. in diameter, and the shorter pieces are the most frequently used. It is important, however, to have the larger tubes as well as the longer ones at all times in readiness for emergency.

METHOD OF PREPARING THE MILK CATHETERS

A pocket knife, three kinds of fine files—namely, flat, triangular, and half-round—sandpaper, and pure beeswax are needed in making the bamboo milk catheters. A ring is made with a knife one centimeter from the base of the tube. The sharp edge of the knife is now applied to the other end of the tube about one millimeter distant from the outer circumference of the hole, and the tissue around the tube is ripped from this end clear down to the ring. After this the outer surface is evened off with the flat file to the desired diameter for specific cases. Some cows require larger catheters than others. The sizes needed can be determined by inserting a probe into the teat canal. When a knob on the catheter is desired as additional contrivance to make it self-retaining, the half-round file should be used. In certain cases it may be advantageous to bore an additional inlet into the tube opening sidewise close to the tip. This is easily done with the edge of the triangular file. The tubes are now made smooth with the finest sandpaper available. After the catheters have been coated with a thin layer of pure beeswax, they are ready for use. Figure 1 shows two sets of the bamboo milk catheters prepared in accordance with the foregoing direction. In set A in the figure the outside diameters of the tubes are 4 mm., the diameters of their holes are from 2.0 to 2.5 mm. In set B, the outside diameters of the tubes are 4.25 mm.; the diameters of their holes are from 2.5 to 3.0 mm.

PRACTICAL APPLICATION

The practical application and advantage of the bamboo milk catheters were noted when a cow which gave slightly above eleven

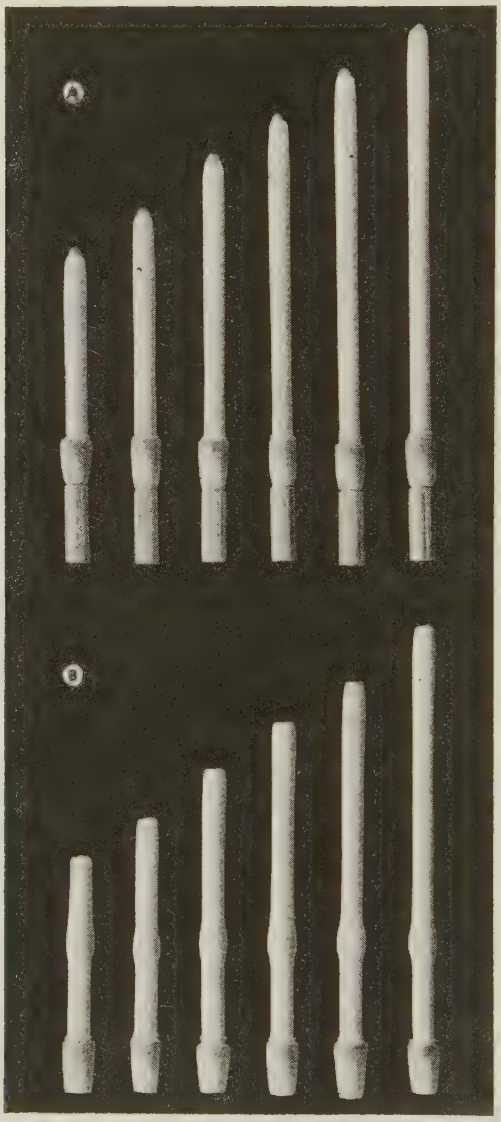

Fig. 1.—Some bamboo milk catheters: *A*, in plain pattern with probes inserted; *B*, in self-retaining pattern. × 2/3.

liters of milk a day during the height of her production in previous lactation suffered from an extensive lacerated wound in the udder

two days after calving. When the wound was examined, it was found that the left fore teat was nearly split in two from its base close to the tip. Eight sutures were required to bring the edges of the wound together. After it had been sutured, the milk continued to leak out between the sutures, thus preventing the tissues from uniting. It, therefore, looked hopeless to try to save the teat.

Bamboo milk catheters were rapidly prepared, and it chanced that the first catheter inserted into the udder held in the teat canal. The presence of a permanent outlet permitted the milk to pass through this outlet as soon as it got into the teat cavity. With an increase of milk production each day, tubes with larger holes were used in place of smaller ones. For a cow yielding as much milk as this one, a catheter with a maximum outlet of 2.0 mm. proved quite sufficient. The free flow of milk through the catheter permitted the wound to undergo normal process of healing, and in about one month the wound was almost closed.

These bamboo milk catheters have an advantage over those made of metal when there is need for holding them in place for a long time because they do not cause any irritation to the living tissues with which they come in contact. We have kept a bamboo tube hanging continuously in the teat canal for as long as 24 hours at a time, for nearly a month without noticing any sign of local inflammation. Undoubtedly, the coating of pure beeswax reduces tissue reaction to the tube in the teat canal. And, since the bamboo does not acquire a temperature higher than that of the tissues with which it is in contact, the chances for infection are reduced to the minimum.

THE EFFECTS OF DIFFERENT KINDS OF PLANTING MATERIALS AND OF A COMMERCIAL FERTILIZER ON THE PRODUCTION OF FLOWERS OF TUBEROSE [1]

VICENTE M. DAWIS AND JOSÉ O. JAUG
Of the Department of Agronomy

WITH TWO TEXT FIGURES

As a cut flower, the tuberose, commonly known as the azucena, has great commercial possibilities in the Philippines. Its varied uses in floral work, the ease with which it can be handled, its good keeping quality, and pure white color make it useful for different purposes. Most flower stores in Manila have a ready supply, which sells at ₱0.60 to ₱0.80 for a dozen stalks.

Wright (1923), Auton (1925), Bailey (1927), and Hottes (1935) have contributed to the knowledge of the fertilizer requirements of the azucena. Separate applications of bone meal, well rotted manure, and cotton seed meal and woodash have resulted in producing robust plants with strong stems and flowers that have a good keeping quality. In the Philippines, the usual practice is to fertilize the plants with small amounts of well rotted animal manure during planting and later when they are about to flower. No study in which a commercial fertilizer was used has been reported locally.

The objects of the present work were: (*a*) to determine the effects of varying amounts of Corona Especial fertilizer, (*b*) to study the influence of different kinds of planting materials upon the yield and quality of flowers, and (*c*) to determine the cost of producing azucena flowers.

The work was performed from April, 1939, to March, 1940, in the floriculture nursery and garden of the Department of Agronomy, College of Agriculture, University of the Philippines, Los Baños, Laguna.

MATERIALS AND METHODS

Planting materials. A single flowering variety furnished by the Floriculture Division was used in this study. The planting materials, bulbs and bulblets, were divided into five classes (fig. 1), total-

[1] Experiment Station contribution No. 1418.

ling 625, and distributed as follows: (*a*) 125 bulbs that had produced flower stalks, (*b*) 125 first class bulblets (2.3 – 2.7 cm. in diameter), (*c*) 125 second class bulblets (1.8 – 2.2 cm.), (*d*) 125 third class bulblets (1.3 – 1.7 cm.), and (*e*) 125 fourth class bulblets (0.8 – 1.2 cm.).

The field between the infirmary and Baker Memorial Hall was used in this experiment. It had an area of 210 square meters and had previously been planted to four species of *Acalypha*.

Fig. 1.—Samples of the five different classes of planting materials used containing 50 pieces each. Class I, bulbs; II, first class bulblets; III, second class bulblets; IV, third class bulblets; and V, fourth class bulblets.

Procedure

Division of the field and arrangement of plantings. The field was divided into five equal lots. The first row of the first lot was planted to bulbs; the second, to first class bulblets; the third, to second class; and so on until the fifth, which was planted to fourth class bulblets. The first row of the second lot was planted to fourth class bulblets, the second, to bulbs, and so on in the same order as the first lot. The first row of the third lot was planted to third class bulblets and again the same arrangement followed as in the first and second lots. The first row of the fourth lot was again planted to second class bulblets, and the first row of the fifth lot, to first class bulblets. The planting of each class was replicated five times.

Preparing the field and planting. The field was plowed four times and harrowed once soon after each plowing. Immediately after the last harrowing, five furrows, approximately twelve centimeters

deep and seventy-five centimeters apart, were laid out. The plants were set thirty centimeters apart in the furrow. Occasional cultivation with the plow, adjusted so as not to disturb the root system of the plant, weeding, and surface tillage with a trowel were done whenever necessary. All vacant hills were replanted.

Applying the fertilizer. Corona Especial fertilizer, containing 5 per cent nitrogen, 8 per cent phosphoric acid (P_2O_5), and 10 per cent potash, was used in this work.

The fertilizer was applied in a circular ring one and one-half inches from the plant and one inch below the surface of the soil. Each lot, which had been planted to five classes of planting materials, was divided into five groups. The first group was the control; the second received 3.6 grams of fertilizer for every hill; the third, 7.2 grams; the fourth, 10.8 grams; and the fourth, 14.4 grams. Each treatment in all the lots was replicated five times in the same way.

In the determination of the amount of fertilizer to be applied per hill, the weight of one tablespoonful of fertilizer, 7.2 grams, was taken as the unit. Hence, 10.8 grams was the weight of one and one-half tablespoonfuls for the third treatment; 14.4 grams, of two tablespoonfuls for the fourth treatment; and 3.6 grams, of one-half tablespoonful for the first treatment.

RESULTS AND DISCUSSIONS

Percentage of germination

In the 30-day calculation, the first class bulblets gave the highest percentage of germination, 78.4 ± 5.025; the second class ranked second with 73.8 ± 6.778 per cent; the third class, third with 70.4 ± 3.359 per cent; the bulbs, fourth with 68.0 ± 4.748 per cent; and the fourth class bulblets, lowest with 64.8 ± 2.792 (table 1). These figures show that as the bulblets decreased in size, the percentage of germination correspondingly decreased.

Percentage of flowering

No difference was found between the percentage of flowering of the bulbs and the second class bulblets (table 2). The difference between the first class bulblets on the one hand and the bulbs and second class bulblets on the other may be due to the fact that the flower spike in the first class bulblets had already been formed when the planting materials were harvested. The bulbs and second class bulblets, although they differed in percentage of germination, did not

differ at all in percentage of flower stalks produced at the time of harvest. The third and fourth class bulblets did not flower at this time.

Effect of fertilizer

With the exception of the first class bulblets in the control lot, no significant difference occurred in the mean height of the entire flowering stalk, length of the flower spike, and number of flower buds in the different planting materials under different treatments. When the different treatments were compared in all classes, no significant differences were observed (table 3).

The fact that the first class bulblets in the control lot showed a significant difference in the height of the entire flowering stalk is not sufficient to conclude that the fertilized lots were better than the unfertilized. This might be due to the fact that the first class bulblets in the control produced an exceptionally dwarfed flower stalk. In that case, the mean would be very much lower. Almost all of the plants showed insignificant differences in length of flower spike and number of flower buds.

Effect of the different planting materials

When plants of the different classes were compared for the mean height of the entire flowering stalk, length of the flower spike, and number of flower buds of the different kinds of planting materials under the different treatments, the results showed that most of the differences were insignificant.

Field operations and costs

Table 4 shows the cost of production. In the preparation of the field, such as plowing, harrowing, furrowing, and preparation of planting materials, the labor cost was valued at ₱1 per day of 8 working hours. The rate for animal labor was also ₱1 a day for 8 hours. These rates give an average of ₱0.13 an hour for man or animal labor.

Plowing. The total time spent for four plowings of the field of 210 square meters was 5.06 hours. Calculated on the basis of one hectare, the total cost was ₱30.95 for man labor and ₱30.95 for animal labor. These costs were the same for the five treatments, because there was practically no difference in the amount of work done on each.

Harrowing and furrowing. The total number of hours spent for four harrowings and furrowing of the plot was 1.55 hours, or a calculated cost of ₱9.52 per hectare for man labor and an equal amount for animal labor. This cost was the same for the five treatments.

Preparation of planting materials and planting. Man labor for preparing the planting materials and planting was 15.3 hours for the entire area. This gave a calculated cost of ₱95.24 per hectare, which was the same in all treatments.

Cultivation and weeding. Under this item man labor required 17.05 hours, and animal, only 0.35 hours. The calculated cost per hectare was ₱104.76 and ₱2.38, respectively, for every treatment.

Application of fertilizer. The amount of labor required in applying the fertilizer was assumed to be the same for all the treatments. All plants under varying amounts of fertilizer were fertilized in 13 hours. This was the same in the four treated lots. The value per treated lot was ₱0.42. The total cost per hectare for each treatment was ₱100.00.

Watering. During the early part of the growing period, the plants had to be watered. The whole area took 3.30 hours of man labor to water, or 0.66 hours for each lot. This cost was valued at ₱0.08, or ₱19.05 a hectare.

Harvesting and preparing the harvest for market. The time spent for harvesting and preparing the flowers for market was 1.44 hours of man labor for the 517 stalks, or an average of 2 minutes for every dozen stalks. The cost of the labor spent in harvesting and preparing the flowers for market was ₱0.04 a lot. The computed value of a hectare was ₱9.52 for the unfertilized as well as for each of the treated lot.

Depreciation and interest [2]

Depreciation of the implements and interest on the investment was ₱0.009 for each lot, or a calculated cost of ₱2.14 per hectare.

The total cost of farm operations was ₱1.31 for the control lot and ₱1.73 for each of the treated lots covering an area of 42 square meters each. On the basis of one hectare the total cost of farm operations was ₱311.89 for the control lot and ₱411.89 for each of the treated lots.

---

[2] For the computation of the depreciation on the implement and interest on the investment, the formula recommended by Catambay (1931) was used.

Cost of the planting materials, fertilizer, and land rent

Cost of the planting materials.[3] The planting materials for each lot, a mixture of an equal number of bulbs and first, second, third, and fourth class bulblets were valued at ₱0.40, or a total cost of ₱95.23 per hectare.

Cost of the fertilizer. The cost of the fertilizer applied per hill in the lot treated with 3.6 grams was ₱0.09; with 7.2 grams, ₱0.18; with 10.8 grams, ₱0.27; and with 14.4 grams, ₱0.36. The computed cost per hectare was ₱21.43, ₱42.86, ₱64.29, and ₱85.72, respectively.

Land rent. The current annual rental for a hectare of agricultural land in the vicinity of the College is ₱20.00. The total area of each lot was 42 square meters, and it was used for 12 months. The imputed rent of the land, therefore, was ₱0.08 for each lot.

Cost of production

Summarizing the cost of production, table 4 shows that for the control lot it amounted to ₱1.80 or a calculated cost of ₱429.26 per hectare; for the lot fertilizer with 3.6 grams, ₱2.31, or ₱550.69; for the lot fertilized with 7.2 grams, ₱2.40, or ₱572.12; for the lot fertilized with 10.8 grams, ₱2.49, or ₱593.55; and for the lot fertilized with 14.4 grams, ₱2.58, or ₱614.98.

The yield and value of the harvest

The yield. The yield of the flower stalks in the control lot was 97 stalks, whereas in the 3.6 gram treatment it was 100; in the 7.2 gram, 104; in the 10.8 gram, 109; and in the 14.4 gram, 107 stalks.

Obviously, the production of flower stalks was less in the control lot than in the fertilized lots. In the fertilized lots more suckers were produced, hence, more stalks. The lot which received the highest amount of fertilizer per hill, however, had two stalks less than the one which received 10.8 grams. This slight difference, however, is not a sufficient basis for concluding that one is better than the other. Nevertheless, the production of the flower stalks increased as the amount of the fertilizer was increased until a peak was reached when further increase in fertilizer did not result in a proportionate increase in production.

---

[3] Based on the current price of planting materials of azucena, which was ₱6 a sack, the amount used in this experiment for the whole five lots was one-third of a sack, or ₱2; this amounts to ₱0.40 a lot. In one count, 1,875 planting materials were found. Of this number there were approximately 378 bulbs and first, second, third, and fourth class bulblets each.

The computed yield per hectare was 23,095 stalks for the control; 23,809 for the lot treated with 3.6 grams per hill; 24,761, with 7.2 grams; 25,952, with 10.8 grams; and 25,476, with 14.4 grams per hill.

Value of the harvest. At Calauan Hacienda, Calauan, Laguna, the current price for one dozen stalks of azucena was ₱0.60 for the single flower variety. Based on this current price, the value of the harvest in the unfertilized lot was ₱1,154.75 per hectare, ₱1,190.45 for the lot treated with 3.6 grams per hill; ₱1,238.05, with 7.2 grams; ₱1,297.60 with 10.8 grams; and ₱1,273.80, 14.4 grams.

Profit and loss

Profit. The total expenditure in the culture of azucena in the unfertilized lot was ₱1.80; the value of the harvest was ₱4.85, or a profit of ₱3.05 per 42 square meters; and the computed gain was ₱725.49 per hectare.

The total expenses incurred in the lot with a fertilizer application of 3.6 grams per hill was ₱2.31. The total value of the harvest was ₱5. A gain was made of ₱2.69, or ₱639.76 per hectare.

The expense in the 7.2 gram lot was ₱2.40. The value of flower stalks harvested was ₱5.20, or a gain of 2.80 for the lot and ₱665.83 for every hectare.

The total expenses for the 10.8 gram lot was ₱2.49 and for the 14.4 gram, ₱2.58. The respective costs of harvest were ₱5.45 and ₱5.35. These figures showed a profit of ₱2.96, or .704.05, and ₱2.77, or ₱658.82, per hectare, respectively.

All lots showed profits. If, however, the profit obtained in the untreated lot is compared with that of the fertilized lots, it will be found that the application of fertilizer resulted in smaller profits.

Disease. From August to December, the months of heavy rainfall (fig. 2), the plants were severely attacked by *Sclerotium rolfsii* Sacc.[4] The disease was very prevalent during the months when rain was abundant. It attacked the portion of the leaves including the flower stalk just above the surface of the ground and caused the leaves and stalk to rot and fall off. This diminished considerably the production of flowers. After some time, however, the attacked plants developed new leaves.

[4] The disease was identified by Mr. Martin S. Celino of the Department of Plant Pathology.

SUMMARY AND CONCLUSIONS

1. The first class bulblets gave 96.8 per cent germination 48 days after planting; the bulbs, 92.0 per cent; second class bulblets, 87.2 per cent; third class, 83.2 per cent; and fourth class, 79.2 per cent.

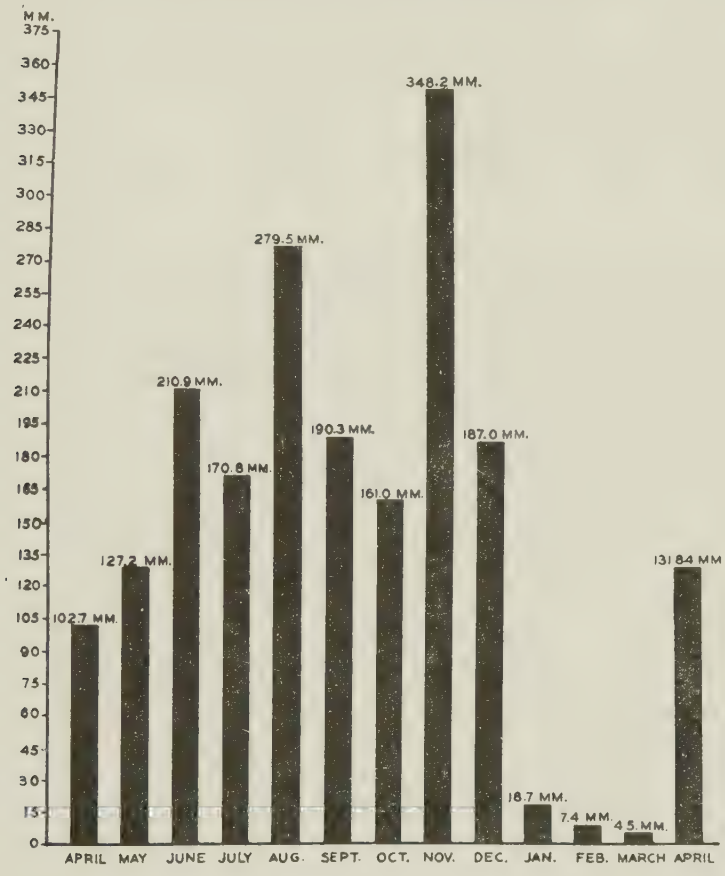

Fig. 2.—Monthly rainfall, in millimeters, in the Agricultural College Weather Station from April, 1939, to April, 1940, inclusive.

2. Sixty-three days after planting, 15.2 per cent of the first class bulblets flowered, whereas only 4 per cent of the bulbs and the second class bulblets flowered. The third class and fourth class bulblets did not flower at this time.

3. No significant difference occurred in the height of the entire stalk, length of the flower spike, and number of buds in the five lots.

4. The unfertilized lot had the fewest flower stalks up to a certain point. As the amount of fertilizer was increased, the number of flower stalks increased also.

5. The computed yield of flower stalks per hectare was 23,095 for the control, 23,809 for the 3.6 gram application per hill, 24,761 for the 7.2 gram application per hill, 25,952 for the 10.8 gram application per hill, and 25,476 for the 14.4 gram application per hill.

The computed value of the harvest per hectare was ₱1,154.75 for the control, ₱1,190.45 for the 3.6 gram application per hill, ₱1,238.05 for the 7.2 gram application per hill, ₱1,297.60 for the 10.8 gram application per hill, and ₱1,273.80 for the 14.4 gram application per hill.

6. The total costs of productions per hectare were ₱429.26 for the control, ₱550.69 for the 3.6 gram application per hill, ₱572.12 for the 7.2 gram application per hill, ₱593.55 for the 10.8 gram application per hill, and ₱614.98 for the 14.4 gram application per hill.

7. The computed gain per hectare was ₱725.49 for the control, ₱639.76 for the 3.6 gram application per hill, ₱665.83 for the 7.2 gram application per hill, ₱704.05 for the 10.8 gram application per hill, and ₱658.82 for the 14.4 gram application per hill.

8. With the conditions under which the experiment was performed, the application of a 5-8-10 Corona Especial fertilizer was not profitable.

LITERATURE CITED

AUTON, W. 1925. The tuberose. The Gardener's Chronicle **77**: 105.

BAILEY, L. H. 1927. The standard cyclopedia of horticulture. Vol. III, v + 3639 p., 39 plates. New York: Macmillan and Co., Ltd.

CATAMBAY, ALEJANDRO B. 1931. Plows and plowing: IV. Cost of plowing with different plowing outfits. The Philippine Agriculturist **20**: 410–422.

HOTTES, ALFRED C. 1935. 1001 garden questions answered. v + 320 p., 102 illustrations. New York: A. T. de la Mare Company, Inc.

MACMILLAN, H. F. 1935. Tropical planting and gardening. 4th ed., v + 560 p. London: Macmillan and Co., Ltd.

SALTER, ROBERT M. 1938. Methods of applying fertilizers. U. S. Dept. Agric. Yearbook **1938**: 546–562.

WRIGHT, RICHARDSON. 1923. Flowers for cutting and decoration. vii + 218 p., New York: E. P. Dutton and Company.

TABLE 1

Percentage of germination of the different planting materials

PLANTING MATERIALS	30 DAYS FROM PLANTING			48 DAYS FROM PLANTING		
	Bulbs or bulblets planted	Average number germinated per lot of 25 bulbs planted	Average percentage germination of 5 lots	Bulbs or bulblets planted	Average number germinated per lot of 25 bulbs	Average percentage germination of 5 lots
Bulbs	125	17.00 ± 1.187	68.00 ± 4.748	125	23.00 ± 0.559	92.00 ± 2.254
First class bulblets	125	19.60 ± 1.254	78.40 ± 5.025	125	24.20 ± 0.539	96.80 ± 2.350
Second class bulblets	125	18.20 ± 1.767	73.80 ± 6.778	125	21.80 ± 0.915	87.20 ± 3.629
Third class bulblets	125	17.60 ± 0.843	70.40 ± 3.359	125	20.80 ± 0.915	83.20 ± 3.649
Fourth class bulblets	125	16.20 ± 0.687	64.80 ± 2.792	125	19.80 ± 0.811	79.20 ± 3.257

TABLE 2

Percentage of flowering of the different planting materials 63 days after planting

PLANTING MATERIALS	BULBS OR BULBLETS	AVERAGE NUMBER FLOWERING PLANTS PER LOT OF 25 BULBS	AVERAGE PERCENTAGE FLOWERING OF 5 LOTS
Bulbs	125	1.00 ± 0.3689	4.00 ± 1.477
First class bulblets	125	3.80 ± 0.3912	15.20 ± 1.564
Second class bulblets	125	1.00 ± 0.3689	4.00 ± 1.477
Third class bulblets	125	—	—
Fourth class bulblets	125	—	—

TABLE 3

Production of flowers

a. Average number of flower buds in the different planting materials under different treatments

CLASS OF BULB	CONTROL	3.6 GM.	7.2 GM.	10.8 GM.	14.4 GM.
Bulbs	29.18 ± 1.62	32.61 ± 1.23	31.66 ± 0.99	33.72 ± 1.33	33.28 ± 1.21
1st class bulblets	26.19 ± 0.84	30.19 ± 0.95	38.00 ± 1.34	29.20 ± 1.31	33.55 ± 1.50
2nd " "	32.08 ± 1.24	32.09 ± 1.11	30.05 ± 1.44	30.61 ± 1.73	28.95 ± 2.37
3rd " "	34.42 ± 2.02	29.57 ± 0.96	29.65 ± 1.30	36.00 ± 1.84	33.67 ± 1.49
4th " "	35.02 ± 0.88	35.93 ± 1.72	32.89 ± 1.25	33.66 ± 1.58	31.38 ± 1.54

b. Average height of the flower stalks in the different planting materials under different treatments

	cm.	*cm.*	*cm.*	*cm.*	*cm.*
Bulbs	74.50 ± 2.21	83.08 ± 2.78	77.41 ± 2.95	82.98 ± 3.58	83.63 ± 3.57
1st class bulblets	66.85 ± 2.25	84.50 ± 1.75	84.50 ± 1.92	81.35 ± 1.80	81.94 ± 2.41
2nd " "	75.66 ± 2.26	82.40 ± 3.41	76.34 ± 3.59	84.11 ± 5.24	80.81 ± 3.43
3rd " "	83.23 ± 3.33	84.56 ± 3.77	81.21 ± 3.90	90.00 ± 3.40	80.40 ± 3.30
4th " "	87.77 ± 2.71	91.20 ± 2.82	87.00 ± 4.81	85.83 ± 3.94	87.31 ± 2.60

c. Average number of flower stalks produced in the different planting materials under different treatments

Bulbs	22	17	27	27	19
1st class bulblets	23	17	20	20	18
2nd " "	17	22	19	26	23
3rd " "	19	21	19	18	16
4th " "	16	23	19	18	21

TABLE 4

Cost in pesos of production

ITEMS	ACTUAL CULTURE OF 42 SQUARE METERS					CALCULATED ON 1 HECTARE BASIS				
	Control	3.6 gms. application	7.2 gms. application	10.8 gms. application	14.4 gms. application	Control	3.6 gms. application	7.2 gms. application	10.8 gms. application	14.4 gms. application
Total cost of farm operations (plowing, harrowing, furrowing, preparation of planting materials, planting, cultivation, weeding, application of fertilizer, watering, and harvesting)	1.31	1.73	1.73	1.73	1.73	311.89	411.89	411.89	411.89	411.89
Depreciation and interest .	0.009	0.009	0.009	0.009	0.009	2.143	2.143	2.143	2.143	2.143
Land rent	0.084	0.084	0.084	0.084	0.084	20.00	20.00	20.00	20.00	20.00
Cost of planting materials	0.40	0.40	0.40	0.40	0.40	95.23	95.23	95.23	95.23	95.23
Cost of fertilizers	—	0.09	0.18	0.27	0.36	—	21.43	42.86	64.29	85.72
Total cost of production ..	1.80	2.31	2.40	2.49	2.58	429.26	550.69	572.12	593.55	614.98
Yield in number of stalks	97.00	100.00	104.00	109.00	107.00	23,095	23,809	24,761	25,952	25,476
Value at ₱0.60 a dozen ..	4.85	5.00	5.20	5.45	5.35	1,154.75	1,190.45	1,238.05	1,297.60	1,273.80
Differences between cost of production and value of harvest	+3.05	+2 69	+2.80	+2.96	+2.77	+725 49	+639.83	+665.83	+704.05	+658.82

PUBLISHED CONTRIBUTIONS OF THE COLLEGE OF AGRICULTURE: XVIII[1]

L. B. UICHANCO
Dean, College of Agriculture

Act No. 2730 of the Philippine Legislature on February 15, 1918, appropriated the sum of ₱125,000 for the establishment of the Experiment Station at the College of Agriculture. The sum was used to buy additional tracts of land to add to the small College campus. Thanks to this aid, we were able to expand almost sixfold to a total area of 397 hectares.

However, since that initial appropriation, no further sum has been voted for development and maintenance of the Experiment Station. The fact that over 25,000 orchard trees and shrubs could be set and made to bear, numerous plant cultures established, and domestic animals acquired which led to the formation of breeds of swine, chicken, and cattle that have either proved their worth or have shown promise of permanent usefulness under Philippine conditions, was due in part to precarious funds eked out by economies in the already meager running expenses of the College and in part to the generosity of friends of this institution.

With special appropriation or without it, research has had to be undertaken, methods to suit local needs have had to be devised or tested, conditions that demand change or improvement studied, problems solved on the spot and new facts brought to light in order to keep collegiate instruction in agriculture vitalized. Not infrequently handicapped by dearth of facilities, the research worker in this College often has had to labor under difficulties which are unknown to more richly endowed organizations. But they have faced the situation without complaint, even happy in the thought that they are given what opportunity they have to undertake creative work, and grateful if any small extra aid comes their way. And the fact that the quantity of output as expressed in the number of titles of Experiment Station contributions in the present list is substantially the same as that in the immediately preceding one, despite reverses suffered during the academic year in the loss of some of the ranking faculty members, can

[1] General contribution No. 777.

only serve to show that the passion for research in this College remains unabated and is not to be easily weakened by handicaps.

I. EXPERIMENT STATION CONTRIBUTIONS

(1355) Rongo, Vicente, and Salud L. Quiatson. 1940. Determination and extraction of pectin from citrus and other fruits. The Philippine Agriculturist **29**: 1–19.

(1356) Calma, Valeriano C., and Julian P. Tiangsing. 1940. The comparative effects of soybean and peanut planted with sugar cane and ammonium sulfate fertilizer upon the yield of sugar cane. The Philippine Agriculturist **29**: 20–33.

(1357) Espino, R. B., and William Crocker. 1940. Effects upon the carbon-nitrogen ratio in leaves of rice grown in Lipa clay loam supplied with varying amounts of ammonium sulfate. The Philippine Agriculturist **29**: 34–47. *Fig. 1–2.*

(1358) Castillo, Adolfo E. 1940. Studies on the correlation between certain characters of Berkjala sows and the size of their litters. The Philippine Agriculturist **29**: 48–54. *Fig. 1.*

(1359) Yango, Clemente E. 1940. A study of two methods of planting corn: with corn planter and by hand. The Philippine Agriculturist **29**: 57–64. *Fig. 1–2.*

(1360) Castillo, Bernardo S., and Martin S. Celino. 1940. Wilt disease of abacá, or Manila hemp (*Musa textilis* Née). The Philippine Agriculturist **29**: 65–85. *Fig. 1–5.*

(1361) Reaño, Potenciano C. 1940. Histological study and observations on the effects of some synthetic growth substances on stem tip cuttings of coffee. The Philippine Agriculturist **29**: 87–99. *Pl. 1–5. Fig. 1.*

(1362) Fronda, F. M., L. P. Zialcita, and Amando M. Dalisay. 1940. The fertility of the duck's egg. The Philippine Agriculturist **29**: 111–123. *Charts 1–6.*

(1363) Vimuktanandana, Yan Yong, and M. S. Celino. 1940. Anthracnose of black pepper (*Piper nigrum* Linn.). The Philippine Agriculturist **29**: 124–141. *Fig. 1–5.*

(1364) Barros, Francisco. 1940. A comparative study of the effects on yield of corn of some leguminous crops used as green manure. The Philippine Agriculturist **29**: 142–149.

(1365) Baltazar, Eulalio P., and M. C. Chakrabandhu. 1940. A study of some of the important characters of cotton varieties grown from selfed and unselfed seeds. The Philippine Agriculturist **29**: 150–172. *Fig. 1–7.*

(1366) Tsui Kwok Hing. 1940. Developmental morphology of the leaf of maguey. The Philippine Agriculturist **29**: 185–225. *Pl. 1–8.*

(1367) GALVEZ, N. L. 1940. A study on the nature of weathering of volcanic tuffs under Los Baños conditions. The Philippine Agriculturist **29**: 226–237.

(1368) VELASCO, JOSÉ R. 1940. Studies on the nutritive value of the Elon-elon rice variety grown in different parts of the Islands. The Philippine Agriculturist **29**: 238–252.

(1369) OBILLO, ALEJANDRO O. 1940. A study of jaragua grass as a forage crop. The Philippine Agriculturist **29**: 253–261.

(1370) ANCHETA, LORENZO M. 1940. Observations on the influence of various methods of feeding ducklings. The Philippine Agriculturist **29**: 262–271.

(1371) SAMANIEGO, RAMON, AND ANTONIO I. DE LEON. 1940. Activated carbon from some agricultural waste products. The Philippine Agriculturist **29**: 275–295. *Fig. 1–2; charts 1–14.*

(1372) UMALI, DIOSCORO L. 1940. A study on coconut seed selection for germination. The Philippine Agriculturist **29**: 296–312.

(1373) JULIANO, J. B. 1940. Viability of some Philippine weed seeds. The Philippine Agriculturist **29**: 313–325. *Pl. 1.*

(1374) ESGUERRA, JOSÉ P. 1940. The cost of producing corn silage at the College of Agriculture. The Philippine Agriculturist **29**: 327–341. *Fig. 1.*

(1375) AQUINO, D. I., AND E. P. SOMBITO. 1940. Studies on sulfofication in soils. The Philippine Agriculturist **29**: 342–349.

(1376) MERCADO, R. G. 1940. Corn-tapilan silage as supplement to pasture for range cattle during the summer months. The Philippine Agriculturist **29**: 350–364.

(1377) SAIYANANDA, CHALERM, AND M. S. CELINO. 1940. Leaf blight of tomato. The Philippine Agriculturist **29**: 365–377. *Fig. 1–4.*

(1378) CELINO, M. S. 1940. Experimental transmission of the mosaic of abacá, or Manila hemp plant (*Musa textilis* Née). The Philippine Agriculturist **29**: 379–403. *Pl. 1–5.*

(1379) MENDIOLA, N. B., AND T. MERCADO. 1940. Introduction and trial culture of Ambon bananas in the College of Agriculture. The Philippine Agriculturist **29**: 415–430. *Fig. 1–2.*

(1380) JULIANO, JOSÉ B., AND CIRIACO RAMOS. 1940. A study of the growth habit of rice plants: V. Fertilization and grain size. The Philippine Agriculturist **29**: 431–451. *Fig. 1–4.*

(1381) MANRESA, MIGUEL, AND PEDRO P. ERCE. 1940. Fluctuation of body temperature in the Jersey and Holstein-Friesian breeds of dairy cattle in the Philippines. The Philippine Agriculturist **29**: 452–462.

(1382) UICHANCO, L. B. 1940. Insect defoliators on Cinchona in Mindanao. Philippine Jour. For. **3**: 45–49.

(1383) MANRESA, MIGUEL, N. C. REYES, FRANCISCO GOMEZ, LORENZO P. ZIALCITA, AND PRUDENCIO R. FALCON. 1940. The influence of atmospheric tem-

perature upon haemoglobin and other constituents of the blood of cattle. Empire Jour. Exper. Agric. 8: 97–100.

(1384) Teodoro, A. L. 1940. Effects of different carburetor settings on the performance characteristics of some makes of automobile engines using alcohol as motor fuel. The Philippine Agriculturist 29: 465–479. *Fig. 1–8.*

(1385) Dawis, Vicente M., and Manuel A. Aaron. 1940. A study of the relation between the length of storage of corms and maturity and yield of gladiolus. The Philippine Agriculturist 29: 480–491.

(1386) Reantaso, Sisenando R. 1940. Manufacture of soft cheese. The Philippine Agriculturist 29: 492–506.

(1387) David, Pedro A. 1940. Trial culture of citronella grass. The Philippine Agriculturist 29: 507–517. *Fig. 1–3.*

(1388) Antonio, Cecilio B. 1940. Studies on the strength of rennet extract product from the stomach of pigs. The Philippine Agriculturist 29: 518–526. *Fig. 1–2.*

(1389) Aquino, D. I., and S. T. Ancheta. 1940. A study of certain chemical and biological properties of different soil media. The Philippine Agriculturist 29: 527–538. *Fig. 1–5.*

(1390) Baltazar, Eulalio P., and Pio A. Tadina. 1940. A test of some wrapper tobacco varieties. The Philippine Agriculturist 29: 539-552.

(1391) Manresa, M., N. C. Reyes, F. Gomez, P. R. Falcon, S. Orig, and L. P. Zialcita, Jr. 1939. The effect of climate upon haemoglobin and other constituents of the blood of cattle. Seventh Internat. Genetical Cong. 1939: 20–21.

(1392) Sacay, Francisco M., and Florendo R. Naanep. 1940. A study of farm, home, and community conditions in a farm village of Ilocos Norte as a basis for formulating a program of rural education. The Philippine Agriculturist 29: 555–570.

(1393) Ongsansoy, Eliseo K., and Ernesto L. Rigor. 1940. A study of the exhaust gases in relation to carburetor adjustments of four- and eight-cylinder automotive gasoline engines. The Philippine Agriculturist 29: 571–592.

(1394) Endrinal, Domingo M., and M. S. Celino. 1940. Septoria leaf spot of tomato. The Philippine Agriculturist 29: 593–610. *Fig. 1–3.*

(1395) Penuliar, Sotero P. 1940. A comparative study of cassava refuse meal and rice bran as feeds for growing and fattening pigs. The Philippine Agriculturist 29: 611–615.

(1396) Galvez, N. L., and Dominador Gaerlan. 1940. The potash-fixing capacity of some Philippine soils. The Philippine Agriculturist 29: 616–625.

(1397) Santos, Paterno R. 1941. Leaf spot of derris. The Philippine Agriculturist 29: 641–659. *Fig. 1–6.*

(1398) CALMA, VALERIANO C. 1941. Studies on the deterioration of burned sugar cane. The Philippine Agriculturist 29: 660–671.

(1399) CATAMBAY, ALEJANDRO B., AND SAWAENG KULTHONGKHAM. 1941. The use of alcohol as fuel for farm engines. The Philippine Agriculturist 29: 672–686. *Charts 1–5.*

(1400) IGTANLOC, PEDRO E. 1941. Comparative studies on the rate of growth and maturity of battery- and range-raised pullets. The Philippine Agriculturist 29: 687–694.

(1401) CADA, ESTEBAN, S. NIPAL, D. C. CUETO, AND I. SACDALAN. 1941. Cultural studies of arrowroot, edible canna, and turmeric in the College of Agriculture. The Philippine Agriculturist 29: 695–705.

(1402) ASICO, PEDRO M. 1941. A comparative study of gaplek meal and corn as basal feed for growing and fattening pigs. The Philippine Agriculturist 29: 706–712.

(1403) FADULLON, LUIS D. 1941. A study of "single-value" properties of soils: Maximum water-holding capacity and shrinkage. The Philippine Agriculturist 29: 713–726.

(1404) ZALDIVAR, JOSÉ P. 1941. The influence of ferric chloride and of zinc sulfate on the production of citric acid from cane sugar. The Philippine Agriculturist 29: 738–752.

(1405) GALVEZ, N. L., AND ISIDORO A. ROMERO. 1941. A study of the preparation of compost from rice straw. The Philippine Agriculturist 29: 753–765. *Fig. 1–8.*

(1406) BINOYA, CORNELIO S. 1941. A comparative study on the value of sugar and corn as basal feed for growing and fattening pigs. The Philippine Agriculturist 29: 766–771.

(1407) BELLO, ANTONIO C. 1941. Fertilizer studies with onion grown on Lipa clay loam in pots. The Philippine Agriculturist 29: 772–790. *Fig. 1.*

(1408) LOSBAÑES, NICANOR L. 1941. The normal feed consumption of Los Baños Cantonese chicks. The Philippine Agriculturist 29: 791–796.

(1409) ESPINO, R. B., AND MANUEL AGDA. 1941. Studies on the fertilizing value of Mayon Volcano ash: III. Effects upon growth, development and yield of upland rice. The Philippine Agriculturist 29: 797–811.

(1410) SANTOS, F. O., AND N. A. PIDLAOAN. 1941. Studies on the foods of 112 families of laborers of the Philippine Lumber Manufacturing Co., Catabañgan, Ragay, Camarines Sur. The Philippine Agriculturist 29: 826–832.

(1411) CASTILLO, ESTEBAN Y. 1941. Effects of certain cryptotrophic elements upon the growth and yield of upland rice. The Philippine Agriculturist 29: 833–850. *Fig. 1.*

(1412) ROJAS, RAMON D. 1941. The effect of pruning at varying ages upon the yield of Ramai rice. The Philippine Agriculturist 29: 851–860.

(1413) YNALVEZ, LAURO A. 1940. Note on the presence of prussic acid in nami, *Dioscorea hispida*. U. P. Natural and Applied Science Bulletin **7**: 273.

(1414) YNALVEZ, LAURO A. 1940. Notes on an inexpensive refluxing apparatus. U. P. Natural and Applied Science Bulletin **7**: 275–277.

(1415) GONZALEZ, L. G., AND PEDRO E. GLORIA. 1941. A study on budding the star apple with special reference to the modified Forkert method. The Philippine Agriculturist **29**: 861–876. *Fig. 1.*

(1416) MADRIGAL, JOSÉ, JR. 1941. Determination of fertilizer requirements of corn plant when grown in Lipa clay loam. The Philippine Agriculturist **29**: 877–891.

(1417) MANRESA, MIGUEL, AND F. B. SARAO. 1941. Bamboo catheters in the treatment of udder troibles. The Philippine Agriculturist **29**: 892–895. *Fig. 1.*

(1418) DAWIS, VICENTE M., AND JOSÉ O. JAUG. 1941. The effects of different kinds of planting materials and of a commercial fertilizer on the production of flowers of tuberose. The Philippine Agriculturist **29**: 896–908. *Fig. 1–2.*

II. GENERAL CONTRIBUTIONS

(738) CAPINPIN, JOSÉ M. 1940. The Los Baños Biological Club: (1933-1940 Summary of achievements). The Philippine Agriculturist **29**: 173–183.

(739) VILLEGAS, VALENTE. 1940. Pasture supplements. Agricultural-Industrial Monthly **7**: 12 and 42.

(740) BASIO, ENGRACIO. 1940. The native chicken. Agricultural Life **7** (1): 17, 34, 39. *Also in* The Philippine Teacher's Digest **8**: 669–671.

(741) VILLEGAS, VALENTE. 1940. My impression of Thailand. Thai Students' Association. The National Day Souvenir, June 24, 1940. p. 29–30.

(742) UICHANCO, L. B. 1940. What I learned from Thai students. Thai Students' Association. The National Day Souvenir, June 24, 1940. p. 18–19.

(743) ARNALDO, MARCELO V. 1940. Scale of living of freshman students in the College of Agriculture. The Philippine Agriculturist **29**: 626–638.

(744) DEL ROSARIO, E. M. 1940. An urgent revision of the English course. Agricultural-Industrial Monthly **7**: 42–52.

(745) DEL ROSARIO, E. M. 1940. Frequencies of errors in high school freshman themes. Philippine Jour. Educ. **23**: 450–452.

(746) BARROS, FRANCISCO. 1940. Fertilization of corn. Agricultural-Industrial Monthly **7**: 19.

(747) BARROS, FRANCISCO. 1940. The value of green manuring in crop production. Agricultural-Industrial Monthly **8**: 18 and 43.

(748) SALCEDO, F. N. 1940. Some experiences in pechay raising in the U. P. Rural High School. Agricultural Life 7: 16, 26, 41, 45.

(749) SALCEDO, F. N. 1940. How would you like to grow chayote in your garden? Agricultural Life 8: 6–7.

(750) CAPINPIN, J. M. 1940. The chromosomes and breeding of Philippine cotton. Agricultural-Commercial-Industrial Life 7: 19 and 27.

(751) ESPINO, R. B. 1940. Ways by which the yield of crop plants may be predicted. Agricultural-Commercial-Industrial Life 7: 11 and 23.

(752) FRONDA, F. M. 1940. Selected clippings for busy farmers. Agricultural-Commercial-Industrial Life 7: 47.

(753) MANRESA, M. 1940. Recently formed breeds capable of growth in the tropics. Agricultural-Industrial Monthly 7: 11–12; 34–35.

(754) MANRESA, M. 1940. Mejoramiento del ganado bovino; sistemas de seleccion propios para la formacion de nuevos tipos de animales para los regioness tropicales. La Hacienda 35: 214–216.

(755) AQUINO, D. I. 1939. The soil as the greatest natural resource of the country. *In* The University of the Philippines on the air. vii + 259 p. Manila: University of the Philippines.

(756) AQUINO, D. I. 1939. Soil requirements of certain agricultural crops. Agricultural Life 6: 4–5, 19 and 44. *Fig. 1–4.*

(757) AQUINO, D. I. 1940. Suggestions for improving and maintaining soil fertility in the Philippines. Sugar News 21: 87–89.

(758) AQUINO, D. I. 1940. Collection of soil samples for soil tests should be performed accurately. Agricultural-Industrial Monthly 7: 23.

(759) AQUINO, D. I. 1940. Geological and topographical surveys required in P. I.'s soil conservation program. Agricultural-Industrial Monthly 7: 23 and 32.

(760) AQUINO, D. I. 1940. The soil and its micro-organic population. Sugar News 21: 229–230, and 232.

(761) AQUINO, D. I. 1940. Use compost to conserve soil moisture. The Philippine Collegian 22: 7. *Also in* Agricultural-Commercial-Industrial-Life 7: 15 and 37.

(762) AQUINO, D. I. 1940. Conserve the soil for future generations. Sugar News 21: 478–482 and 484. *Fig. 1–4.*

(763) GALVEZ, N. L. 1940. Fertilizing value of human feces. Agricultural-Industrial Monthly 7: 53.

(764) AGLIBUT, ANDRES P. 1938. College of Agriculture Scouts encircle Mt. Maquiling on bicycles. Philippine Scouting 2: (November issue).

(765) CALMA, VALERIANO C. 1940. Why not rimas flour? Agricultural-Industrial Monthly 7: 3, 24, 37. *Fig. 1–2.*

(766) Calma, Valeriano C. 1940. Rimas cakes and cookies. Agricultural-Industrial Monthly **7**: 27–28. *Fig. 1.*

(767) Calma, Valeriano C. 1940. Coconut husks for potting plants. Agricultural-Industrial Monthly **7**: 4–5, 32 and 36. *Fig. 1–4.*

(768) Calma, Valeriano C. 1940. Experiments on intercropping sugar cane with legumes and fertilizing with ammonium sulfate. Sugar News **21**: 189. *Also in* So. African Sugar Jour. **24**: 339. 1940.

(769) Aglibut, Andres P. 1940. Tenth anniversary of Scouting at Los Baños. Philippine Scouting **3**: 9, 25, and 26.

(770) Aglibut, Andres P. 1940. Modern farmhouses. Agricultural-Industrial Monthly **7**: 3 and 17.

(771) Fronda, F. M. 1941. A report on a recent visit to Australia. The The Philippine Agriculturist **29**: 729–737. *Fig. 1–2.*

(772) Fronda, F. M. 1941. The livestock industry of Australia. The Philippine Agriculturist **29**: 813–825. *Fig. 1–5.*

(773) Villegas, Valente. 1940. The breeding habits of the water buffalo. Agricultural-Commercial-Industrial Life **7**: 20.

(774) Ganzon, Guadalupe F. 1940. Loyalty and the College of Agriculture. Agricultural-Commercial-Industrial Life **7**: 16, 17, and 38.

(775) [Mack, Ruth M.] Lynn, Mary. 1940. Lolita. Philippines Free Press **34**: 12–15.

(776) Galvez, Nicolas L. 1941. Agricultural lime. Sugar News **22**: 7–8.

(777) Uichanco, L. B. 1941. Published contributions of the College of Agriculture: XVIII. The Philippine Agriculturist **29**: 909–916.

III. MISCELLANEOUS CONTRIBUTION

(23) Jenkins, Anna E., and A. A. Bitancourt. 1940. An *Elisinoe* on *Toddalia.* The Philippine Agriculturist **29**: 55–56.

COLLEGE AND ALUMNI NOTES

The Junior Class Organization of the College held its annual program and dance at the Seniors' Social Garden on December 14, 1940. Mr. Melecio Palacios, Jr., is the class president and Dr. José M. Capinpin is the adviser.

Mr. Pedro S. Paje, '27, was recently appointed superintendent of the Iwahig Penal Colony in Palawan.

Mr. Salvador Oliveros, '33, was sent to the United States as a pensionado of the National Rice and Corn Corporation under which he had been serving as chemist. He is to pursue studies on the chemical utilization of rice and corn by-products.

The annual Christmas "lechonada" party for the students of the College and U. P. Rural High School was held at Molawin Hall, on December 23, 1940.

A shipment of 81 chickens, including 35 S. C. White Leghorn weanling pullets and 5 cockerels and 35 Australore weanling pullets and 6 cockerels, was received by the College from Brisbane, Queensland, Australia, on January 9. Part of the consignment will go to the Bureau of Prisons.

The senior class of the College held its annual program and dance at the Seniors' Social Garden on January 11. Mr. Higino Marquez is the class president, and Professor Alejandro Catambay, adviser.

Dr. G. A. C. Herklots, reader in biology at the University of Hongkong, arrived on December 28, 1940, from Hongkong by Clipper to join his family which has been in residence on the College campus for about a year. Doctor Herklots stayed until January 7.

Prof. W. E. Hoffman, entomologist and director, Lingnan Natural History Survey and Museum, Lingnan University, Canton,

China, visited the College with Mrs. Hoffman on January 1. Professor Hoffmann worked part of the time in the entomological museum of the College but most of his stay was devoted to collecting aquatic hemiptera on Molawin Creek.

The latest assignments of some alumni of the College to ranking positions in the Bureau of Education are as follows: Dr. Felipe O. Cevallos, '12, acting superintendent of Bukidnon National Agricultural School; Mr. Pedro Montellano, '15, and Mr. Constancio T. Medrana, '27, acting supervisors of agricultural instruction; Mr. Elias M. Caray, '21, acting supervisor of Type A schools.

President and Mrs. B. M. Gonzalez entertained members of the College faculty and employees at a dance held at Molawin Hall on New Year's eve.

Dr. Manuel L. Roxas, '11, was recently designated member of the sugar advisory board by President Quezon.

Dr. Roxas visited the College on January 29.

President Bienvenido M. Gonzalez, '13, was appointed member of the National Council of Education by President Quezon.

The following students of the College were recently elected for membership to the honor society Phi Kappa Phi: Seniors—Hipolito A. Custodia, Chan Meesukh, Bruno Santos, Glicerio Garcia, Luciano Lactao, and Pedro Peralta; graduate student—Hsieh Feng Yuan.

Two former assistant professors of agronomy of this College are assisting General Paulino Santos in opening underpopulated parts of the country to setlers. Prof. Mariano B. Raymundo, until lately supervising agriculturist in the Koronadal Valley project of the National Land Settlement Administration, was recently transferred to Mallig, Isabela, to occupy a similar position there. Dr. Eulalio Baltazar, '22, takes the place of Professor Raymundo in Koronadal.

Recent visitors to the campus include the following: Mr. Kingsley Hamilton, Vice Consul for Saigon, French Indo-China, who was once a special student of the College; and Mr. Griffin of the World Travel Association who came to take moving pictures in connection with a travelogue on Philippine life.

THE EXPERIMENT STATION

LIST OF AVAILABLE CIRCULARS

Circular No. 2.—Bud Rot of Coconut (Revised, June, 1934) - - - *By G. O. Ocfemia*

Circular No. 3.—Experimental Errors and Application of the Probable Error to and the Interpretation of Experimental Results - - - - - - - - - - - - - *By Nemesio B. Mendiola* (Published as Chapter IV in *A Manual of Plant Breeding for the Tropics*, 1926, also sold by THE PHILIPPINE AGRICULTURIST at ₱3.25, paper bound, and ₱5.25, cloth bound, in the Philippines, and ₱3.50 and ₱5.50 elsewhere, postpaid.)

Circular No. 5.—Poultry Raising Made Easy (Revised) - - - - *By F. M. Fronda*

Circular No. 7.—How to Produce New Varieties of Gumamela (Hibiscus) - - - - - - - - - - - - *By Nemesio B. Mendiola*

Circular No. 8.—Horse Breeding in the Philippines - - - - - *By Valente Villegas*

Circular No. 9.—Fences for Farm Animals - *By B. M. Gonzalez and J. P. Esguerra*

Circular No. 10.—Practical Directions for Coffee Planting - - - *By Pedro A. David*

Circular No. 11.—The New College Copra Drier—Prepared in *Department of Agricultural Chemistry* with cooperation of *Department of Agronomy and Extension*. (Revised by *Moises M. Kalaw*).

Circular No. 14.—Beriberi: Its Causes and Prevention - - - - - *By F. O. Santos*

Circular No. 15.—Cattle Raising under Philippine Conditions - - *By Valente Villegas*

Circular No. 16.—A Simple Farm Record for the Farmer - - *By Francisco M. Sacay*

Circular No. 17.—College Trapnest - - - - - - - - *By F. M. Fronda and P. S. Paje*

Circular No. 18.—Surveying for Area with a Surveyor's Staff - *By Alexander Gordon*

Circular No. 19.—A Pageant: Illustrating the History and Growth of the College of Agriculture - - - - - - - - - *By Anne F. Cole*

Circular No. 20.—Amount of Nutrients in Philippine Food Materials - - - - - - - - - *By F. O. Santos and S. J. Ascalon*

Circular No. 21.—Cassava Growing and Cassava Starch Manufacture - - - - - - - - - - - *By Nemesio B. Mendiola*

Circular No. 22.—Goat Raising - - - - - - - - - - - - - - *By Valente Villegas*

Circular No. 23.—Curing Pork and Making Sausage for Home Use - - - - - - - - - - - - - - - *By Mariano Mondoñedo*

Circular No. 24.—Construction and Operation of Silos in the College of Agriculture - - - - - - - - - - - - *By José P. Esguerra*

Circular No. 26.—Training Cattle and Carabaos for Work - - - *By Valente Villegas*

Circular No. 27.—Bunchy-top of Abacá - - - - - - - - - - - - *By G. O. Ocfemia*

Circular No. 28.—Cotton Culture - - - - - - - - - - - - - *By Eulalio P. Baltazar*

Circular No. 29.—Collegiate Education in Agriculture - - - - *By L. B. Uichanco*

Circular No. 30.—What Should Filipino Ornamental Gardens and Ornamental Plants Be? - - - - - - - - - - *By N. B. Mendiola*

Circular No. 31.—How to Slaughter and Dress Farm Animals - - - - - - - - *By Valente Villegas and M. Mondoñedo*

The Circulars Nos. 1, 3, 4, 6, 12, 13, and 25 are out of print.

The price of the Circulars listed above is 10 centavos each except Nos. 5, 10, 16, 21, and 30 the price of which is 20 centavos.

ALL ORDERS SHOULD BE ADDRESSED TO THE BUSINESS MANAGER, THE PHILIPPINE AGRICULTURIST, AGRICULTURAL COLLEGE, LAGUNA, PHILIPPINES

The Philippine Agriculturist

(Formerly The Philippine Agriculturist and Forester)

Published by the COLLEGE OF AGRICULTURE
UNIVERSITY OF THE PHILIPPINES

Vol. I—2
Vol. II—4-6
Vol. III—9-10
Vol. IV—3, 5-6, 7
Vol. V—2, 3, 5, 6, 7, 8, 9, 10
Vol. VI—complete
Vol. VII—complete
Vol. VIII—3, 4, 5, 6, 7, 8-9, 10
Vol. IX—3, 4-5, 8-9
Vol. XI—3, 4, 5, 6, 7, 8
Vol. XII—10
Vol. XIII—1, 3, 4, 5, 6, 8, 9, 10
Vol. XIV—complete
Vol. XV—complete
Vol. XVI—3, 5, 6, 7, 8, 9, 10
Vol. XVII—6, 7, 8, 9, 10
Vol. XVIII—complete
Vol. XIX—complete
Vol. XX—complete
Vol. XXI—complete
Vol. XXII—complete
Vol. XXIII—complete
Vol. XXIV—complete
Vol. XXV—complete
Vol. XXVI—complete
Vol. XXVII—complete
Vol. XXVIII—complete
Separate indices to Vol. I to XXVIII
Consolidated index to Vol. I to XX

Back copies sell at 40 centavos. Indices 10 centavos each.

Consolidated index 50 centavos excluding postage

Send your order to the BUSINESS MANAGER, THE PHILIPPINE AGRICULTURIST, AGRICULTURAL COLLEGE, LAGUNA, PHILIPPINES.

A Handbook of Philippine Agriculture

A new book on practical agriculture issued in commemoration of the Thirtieth Anniversary of the College of Agriculture. Contains useful information on different branches of agriculture. Of great practical value to farmers, farm managers, agricultural teachers, students, extension workers, and researchers.

Cloth 803 pages 4½" × 6¾"

Price postpaid:

Philippines ..... ₱2.30
United States and foreign countries 2.60

Send your order to THE PHILIPPINE AGRICULTURIST, AGRICULTURAL COLLEGE, LAGUNA, PHILIPPINES